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A double triple-expansion engine of 2,400 HP. has just been started at Fall River for the Iron Works Co. in their new shops. This engine was designed and built by the Corliss Co., of Providence, R. I. It has two 23½-in., two 36½-in. and two 54-in. The driving wheel is 28 ft. in diameter and has a face of 15 ft. 4 ins. covered by four belts; one 38 ins., two 44 ins. and one 50 ins. wide. These belts are three-ply of leather and they weigh nearly four tons. They were made by the Union Belt Co., of Fall River.

Work is progressing on the south or bank wall of Lock No. 2 of the Black Warrior River improvement at Tuscaloosa, Ala. During the month of August, 1892, two gangs of masons, three masons to the gang, working 8 hours per day, laid and pointed 2,370 cu. yds. of masonry at a total cost of $1,838.96, or 77.6 cts. per cu. yd. This does not include the cost of stone or cement, of course, but does include cost of screening sand, mixing mortar, unloading materials at the wall, operating steam hoists, fuel for same, and building and pointing the masonry.

Foreman, 1 month,		$100.00
Masons, 147½ days,	@ $3.50	516.25
Laborers, 27½ days,	@ $1.50	41.25
" 108 days	@ $1.25	135.00
" 510½ days	@ $1.00	510.50
" 216 days	@ $.80	172.80
" 180½ days	@ $.75	139.88
" 103 days	@ $.55	56.65
Boys, 87¾ days	@ $.50	43.88
Wages paid in board		100.00
Fuel		22.75
		$1,838.96

This gives an average of 16 cu. yds. per mason per day.

About 5-12 of the wall is dry rubble. The balance is first class masonry in Portland cement mortar. In our issue of Nov. 21, 1891, was given the cost of masonry on the north wall.

An elevated electric railway has been established at the stock yards at Chicago, It connects all the P. D. Armour warehouses and slaughter houses. There are about 6,000 ft. now completed and about two miles of extensions are being built. The track has a gage of 3 ft. and is 23 ft. above the ground. Where the line runs between the main buildings the structure is of steel; elsewhere it is of Georgia pine. The numerous switches necessary to reach all parts of the buildings made the construction difficult to plan satisfactorily. The iron work was designed and erected by Mr. John Bouchard, master mechanic for the Armour company. The electrical work was done by the Thomson-Houston Co., under the supervision of Mr. A. Shillingiaw, electrician for the Armour company. There are in service two 20 HP. locomotives of the standard Thomson-Houston type. The cars may be run off the rails on to the floors of the different houses. The power house is located about a quarter of a mile from the road, and will be some distance beyond that when the company moves into the new electric station, occupying a building 125 × 150 ft., and comprising three stories, built of steel and brick, with the engines located on the first floor, shafting on the second and dynamos on the third. Current for the present equipment is supplied from a Thomson-Houston 135 HP. generator, and there is also ready for service a National 80 HP. machine.

Ten compound consolidation engines of the Vauclain four-cylinder type are being built by the Baldwin Locomotive Works, Philadelphia, Pa., for the new Buffalo line of the Lehigh Valley R. R. They will have the Westinghouse automatic driver and tender brake, steel-tired truck and tender wheels with Vauclain wrought iron centers, Nathan lubricators, and wristpins bored and oil tempered; also iron tender frames, Jerome metallic packing, and roof over tender. The principal dimensions are as follows:

Cylinders, h. p.	14 × 26 ins.
Cylinders, l. p.	24 × 26 ins.
Driving wheels, diam.	4 ft. 7½ ins.
Boiler	5 ft. 6 ins.
Firebox, with combustion chamber	9 ft. 6 ins. × 8 ft. 0 ins.
Weight, on drivers, in working order	126,000 lbs.
Weight, total, in working order	142,000 lbs.
Tank, capacity	4,000 gallons.

The most serious railway accident of the week was the derailment of a freight train Oct. 10 at Bennettsville, S. C., on the Charleston, Sumter & Northern R. R. A freight car left the track, and caused the wreck. Three men were killed and three injured.—Another serious railway accident was a head collision, Oct. 3, at Northtown Junction, Minn., on the Northern Pacific R. R. A passenger train ran into a freight train which was behind time. One man was killed, another fatally injured and seven injured.

A trestle near Hayes, Miss., on the Louisville, New Orleans & Texas Ry., gave way under a passenger train Oct. 7. One man was killed. Two passenger cars, a baggage car and a sleeping car were burned.

A submarine cable across the Pacific between Australia and British Columbia is projected, and Sir George Dibbs, Premier of New South Wales, recently visited London to promote the laying of this cable, thus securing telegraphic communication between England and Australia through British territory. Sir Geo. Dibbs stated that a large trade might be done between the two countries, and the trade now going to San Francisco might be secured to Canada, if there were such direct communication. It would be a good thing for the colonies to have a cable entirely laid and connected through British territory in case of war. The proposal is to lay a cable from Queensland Port to New Caledonia, which would be the first chain in the link of the Pacific cable to Victoria, B. C., by way of Fiji, Samoa and Honolulu. New South Wales would contribute $10,000 annually toward the New Caledonian line, and Queensland has arranged to contribute $20,000.

Twin screws beat side wheels in a scrub race between the Sound steamers "Puritan" and "Richard Peck." The latter is a new steamer built at Wilmington, Del., for the New Haven Line, and is the first boat regularly running on Long Island Sound to use twin screws, though single screw steamers have been running for some time.

Smoke stacks 100 ft. high are to be applied to the new armored cruiser No. 3. Her three stacks will be each 30 to 40 ft. higher than those of any other United States war ship; and while the value of these high stacks in doing away with forced draft in ordinary steaming is recognized in merchant vessels, our navy is the first to adopt them for war ships. Another important gain by reason of this height of stack is that the smoke and gas will be carried above the military masts and enable the guns there to be better worked. The one objection is that they give the ship a very awkward look.

A national league for good roads is to be organized at Chicago during "Dedication Week" of this month. The call is signed by many state road improvement associations, and individuals prominent in the movement. They ask all local road improvement societies, boards of trade, chambers of commerce, League of American Wheelmen, farmers' associations, etc., to send representatives to this preliminary meeting.

A powerful electric search light, recently established at Mount Washington, N. H., is to be removed to Mount Wilson, Cal., this winter, according to a Pasadena paper. Prof. Lowe, President of the Pasadena & Mount Wilson Ry. (Eng. News, July 14), has been negotiating for this change, and the plant will be erected by Mr. L. H. Rogers, who was electrician for the installation of the Mount Washington plant.

The deposits of fuller's earth in Bedfordshire, England, have been known for some time, but little has been done toward utilizing the earth for industrial purposes. Recently a company has been formed to work some of the mines, which have been planned and galleried by Mr. A. J. G. Swinney. At Woburn Sands, where the deposits of fuller's earth occur, the lower greensand attains its maximum thickness, and the lower beds alone contain the fuller's earth. The layers of earth, as they come to be worked, are found to be irregularly deposited in ridges and furrows, and the different layers vary in color alternately from yellow to blue. From the chemical analyses of these earths of different color, no difference in composition can be detected, and they all seem to possess the same commercial value. The Fuller's Earth Mining Co., which has acquired the mines, is now at work extending the underground galleries, which already run many hundreds of feet. The earth is said to be very free from sand and gritty particles, and therefore requires no washing or refining before it is fit for use. Fuller's earth is largely used for washing and cleansing woolen and other fabrics in the course of manufacture and dyeing, and recently a large demand for refining fats and oils has sprung up in the United States and elsewhere, so that there is a prospect of the industrial development of these mines in the immediate future, provided the cost of working can be kept low.

The cost of iron ore carriage on the Great Lakes in modern steel propellers (interest and depreciation on plant not included) is less than one-half mill per ton mile, according to figures recently given in the "Marine Review," for the Minnesota Steamship Co.'s steamer "Manola." During the season of 1890, this ship was in commission 222 days, of which 175 days were passed in actual sailing, and 47 days in port. She made 30 round trips, and carried 71,171 tons of iron ore, or an average of 2,372 tons per trip. The average time spent in loading was 7½ hours; in unloading, 12 hours. The average time required for a round trip was 7 days, 9½ hours, the average mileage being 1,686 miles per trip.

The average speed of the ship was 12.72 miles per hour light, and 11.85 loaded, and to attain this she burned an average of 209 lbs. of coal per mile light, and 226 lbs. when loaded. She carried a crew of 23 men. The total distance traveled during the season was 50,584 miles, and the total ton-mileage of freight carried was 3,600,079. It must be remembered that cargo is carried only one way, the up trip to Lake Superior being made light.

The total earnings of the ship for the season were $93,738; the expenses were, $55,114, or 58.8% of the earnings, and the net earnings were, $38,624. She thus earned an average of $422 gross, and $174 net per day while in commission.

The following averages are derived from these figures:

	Per mile traveled. cts.	Per ton carried. cts.	Per ton mile. ct.
Earnings	185.3	131.7	0.078
Expenses	109.0	77.4	0.046
Net earnings	76.3	54.3	0.032

The principal items in the expense account were:

	Amount.	% of total.
Handling cargoes	$16,112	29.2
Fuel	14,427	26.2
Labor	10,021	18.2
Provisions and supplies	3,305	6.0
Insurance	5,471	9.9
Miscellaneous	5,778	10.5
Total	$55,114	100.0

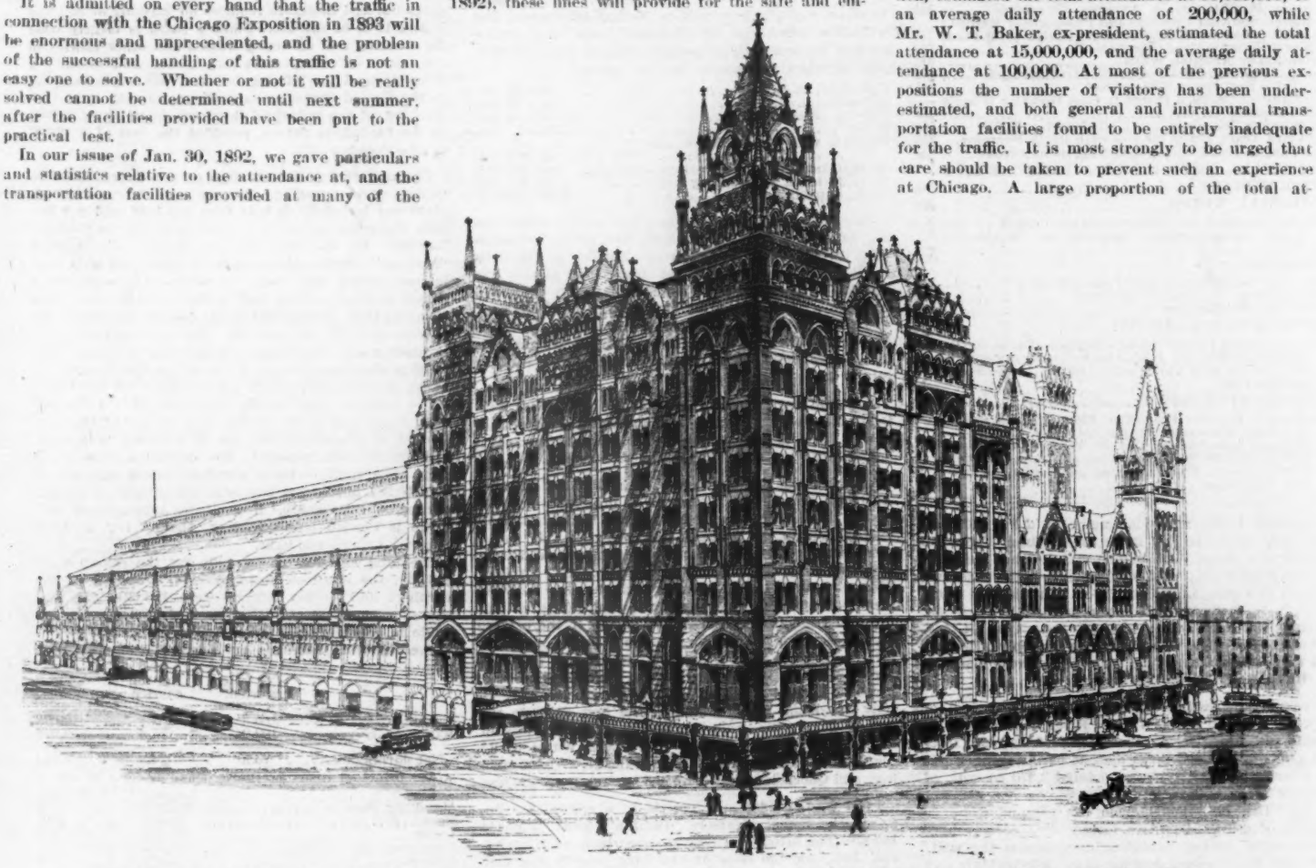
In an extensible trench brace, recently put on the market in Germany, the pressure is applied to the wall plates by a double-toggle joint, the opposite angles of which are drawn together by a screw to tighten the brace. Unless the legs of the toggle are given a good deal of spread at the center, the brace forms a compression member very liable to failure by buckling. Another fault is that the range of adjustability is small, and as the leverage of the screw to straighten the toggle increases as the brace lengthens, a careless workman is very likely to break the brace by continuing to turn after the brace is tight enough. If this is the best the Germans can do in this line, they had better copy American practice. We illustrated a trench brace of American manufacture in our issue of July 7, 1892.

Two Pullman cars have been put on by the London & Southwestern Ry. to run between London and Southampton, 79 miles, in connection with the steamer and other traffic incidental to the use of the port of Southampton by the Inman Line and Red Star Line of steamers, as noted in our issue of Oct. 5. The Pullman car service over this road between London and Bournemouth, 110 miles, was described in our issue of April 18, 1891. The railway company is also building a number of passenger cars of the most modern English pattern, as well as a number of refrigerator cars, all for the Southampton service, which will be commenced next spring.

Boise City, Idaho, is to be heated by hot water from boiling water from the large artesian wells lying about one mile from the city. The water is to be carried in a 6-in. pipe, and the cost of heating is estimated as being 50% less than by coal.

THE NEW BROAD ST. STATION OF THE PENNSYLVANIA R. R.

We gave last week the plans of the new passenger station and trainshed which is to be erected by the Pennsylvania Railroad at its Broad St. terminus, in Philadelphia. The accompanying cut is a perspective view of the new station, furnished us by the courtesy of Chief Engineer Wm. H. Brown. The upper stories of the new building will be used for offices.



THE NEW BROAD ST. STATION OF THE PENNSYLVANIA RAILROAD AT PHILADELPHIA, NOW UNDER CONSTRUCTION.

WORLD'S COLUMBIAN EXPOSITION.
Transportation.

It is admitted on every hand that the traffic in connection with the Chicago Exposition in 1893 will be enormous and unprecedented, and the problem of the successful handling of this traffic is not an easy one to solve. Whether or not it will be really solved cannot be determined until next summer, after the facilities provided have been put to the practical test.

In our issue of Jan. 30, 1892, we gave particulars and statistics relative to the attendance at, and the transportation facilities provided at many of the previous expositions. In our issue of June 9, 1892, we presented at some length the arrangements then being made for the transportation of passengers from the city to the Chicago Exposition grounds, and have in different articles referred to the arrangements for intramural transportation. On the accompanying sketch map are indicated the several lines of transportation to and within the grounds, with the exception of the Chicago City Ry. Co.'s Cottage Grove Ave. and State St. cable lines, which do not touch the grounds. The former line, by the completion of its loop at 55th St., will run within two blocks of the north entrance of the grounds, while the main line of the latter is two miles distant, necessitating transfer to crosstown lines which will be operated by electricity. For these crosstown lines the Chicago City Ry. Co. has awarded to the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., a contract for four 200 HP. generators and the equipment of 60 cars with single reduction motors. The facilities for transportation to and from the city, as indicated on the map, are as follows: A, general terminal station for excursion trains over the several lines having access to the grounds, as described in our issue of June 9; B, suburban stations of the Illinois Central R. R.; C, terminal station of the Chicago & South Side Elevated Ry., which was described and illustrated in our issue of Jan. 10, 1892; D, landing piers for steamers from Chicago and lake ports. The intramural transportation facilities are as follows: E, elevated electric railway of the Columbian Intramural Ry. Co.; F, the Barre hydraulic sliding railway; G, electric and steam launches; H, movable sidewalk. In addition to these general systems of intramural transportation concessions have been awarded for other facilities adapted for individual use, including cabs, electric wheel chairs, electric wagonettes, Japanese jinrikishas, and probably others.

Various estimates have been made of the probable daily attendance at the exposition, and the carrying capacity of the transportation lines. As stated by Mr. J. F. Wallace, Chief Engineer of the Illinois Central R. R. (Eng. News, June 9, 1892), these lines will provide for the safe and efficient handling of at least 100,000 people per hour, of which the Illinois Central R. R. itself, with the improved facilities being provided specially for this traffic, will handle 21,000 persons per hour. Besides this total of 100,000 persons, however, there will be the people who walk and come by cabs, omnibuses and other vehicles. In October, 1891, a report on transportation facilities was made by the Subcommittee on Physical Difficulties, consisting of Mr. L. A. Clarke, City Engineer of Chicago; Mr. J. F. Wallace, Chief Engineer of the Illinois Central R. R.; Mr. R. J. Hill, Engineer of the Chicago City Ry., and Mr. D. H. Burnham, Director of Works. Their estimate as to the number of visitors was as follows, but the proposed independent loop system was abandoned later:

	Passengers per hour.
Foot passengers and sundry vehicles	25,000
Chicago City Ry., Cottage Grove cable line	20,000
" " State St. and 63d St. line	20,000
Illinois Central R. R., existing tracks	21,600
" independent loop	14,400
Water transportation, between lake front and Jackson Park	10,000
Water transportation, between points on the North Side and Jackson Park	5,000
Chicago & South Side elevated railway	20,000
Total per hour	136,000
Total per hour, exclusive of loop	121,600

These figures have been considered as too high, but such estimates are more likely to be too low than too high, and the members of the committee were men of extensive practical experience in transportation matters. In any case it will be better to provide for a greater number than is actually required, rather than to have the trouble, danger and annoyance due to insufficient capacity of the transportation facilities. Another estimate based on the figures of the transportation companies is as follows:

	Passengers per hour.
Lake steamers	15,000
Illinois Central R. R.	25,000
Cable lines	25,000
Elevated railway	20,000
Foot passengers and sundry vehicles	25,000
Total	110,000

Mr. H. N. Higinbotham, president of the exposition, estimated the total attendance at 30,000,000, or an average daily attendance of 200,000, while Mr. W. T. Baker, ex-president, estimated the total attendance at 15,000,000, and the average daily attendance at 100,000. At most of the previous expositions the number of visitors has been underestimated, and both general and intramural transportation facilities found to be entirely inadequate for the traffic. It is most strongly to be urged that care should be taken to prevent such an experience at Chicago. A large proportion of the total attendance will be crowded upon the transportation lines at certain hours of the morning and afternoon, so that the traffic facilities must be arranged with a view to the prompt and safe handling of a rush. The exposition will be kept open at night and this will tend to extend the departing traffic over a greater time, but even then there will always be a large number of people remaining to the last moment. An important point will be to have ample facilities for entrance and exit at the gates and railway and steamer terminals, and to provide sufficient signs and directions to enable visitors to find their way about the grounds and to the stations, etc., as well as to find their particular trains at the main terminal. The transportation lines must also provide ample motive power and rolling stock equipment for the accommodation of the traffic, if this traffic is to be handled promptly and with reasonable comfort and convenience for the passengers.

The attendances at the Centennial Exhibition at Philadelphia, Pa., in 1876, and at the Paris Exposition in 1889, are said to have been used to some extent in forming the Chicago estimates for 1893, and some particulars of the attendance at these previous expositions will be found in our issue of Jan. 30. At Philadelphia the transportation problem was of rather minor importance, the grounds being practically within the city, but on Pennsylvania Day, the day of the largest attendance, it is said to have been 3 o'clock the next morning before

the crowd reached the heart of the city. The total carrying capacity of railways, street cars, steamers, omnibuses, etc., was 21,930 passengers per hour. At Paris the total carrying capacity was 173,750 passengers per hour, which proved entirely inadequate. In view of these previous experiences ample provision should be made for the transportation of a daily average of 200,000 persons for a distance of seven miles at Chicago next year. The intramural transportation was provided for at Philadelphia mainly by a double-track narrow-gage surface railway 5.5 miles long, and at Paris by a railway of 2 ft. gage, 2 miles long (Eng. News, June 1, 1889). In the latter case the facilities were quite inadequate (Eng. News, June 1, 1889).

	1876. Philadelphia.	1889. Paris.
Total attendance	10,000,000	32,354,111
Average daily attendance	62,802	102,281
Highest " "	274,919	387,877
Lowest " "	12,720	36,322

In April, 1892, in consequence of the large number of visitors to the Chicago grounds, it was decided by the exposition management to charge an admission fee of 25 cts., and we learn from Mr. A. F. Seeberger, Treasurer, that from the date of beginning to charge admission, April 17, to Sept. 22, the gate receipts amounted to $111,659. The largest attendance in a single day was 15,000 visitors, on Sunday, Sept. 18, and during August there was an average daily attendance of 3,000 persons.

We will now briefly consider the several systems of transportation between the city and the exposition grounds, more complete particulars of which we shall probably publish in later issues.

A. General Terminal Station.—This is for the accommodation of the excursion traffic of all the main railways which center in Chicago, and is intended for excursion trains from country points carrying passengers to the grounds in the morning and out at night. It is intended that these trains shall run direct to the Exposition grounds, over the various railways entering the city of Chicago, from all points within a radius of 300 or 400 miles. Long distance passengers by the regular trains will be brought by the various railways to their city terminal stations. Fig. 2 is a plan of the tracks at this station. There are 36 tracks on a 12° curve, arranged in groups of three, spaced 13 ft. c. to c., with platforms 30 ft. wide between the groups. The two outer tracks are for trains, and the middle one is to allow the engines to back out into the yard. In the yard will be two turntables 66 ft. in diameter, a water tank and stand-pipes or water-cranes for supplying the tender tanks. The terminal is approached by four main tracks and will be equipped with a complete interlocking switch and signal plant so as to provide for the safe and efficient handling of the traffic. The contract for this plant has been awarded to the Wuerpel Switch and Signal Co., of St. Louis, Mo. The dotted line on the plan indicates the outline of a loop system of terminals suggested by Mr. Isham Randolph, Consulting Engineer of the Baltimore & Ohio R. R. and Mr. R. B. Campbell, General Superintendent of the same road; the platforms and tracks being within the area outlined. The covered platform will be 100 ft. wide and 650 ft. long. The cost of this terminal station, including a handsome passenger station, is $140,000.

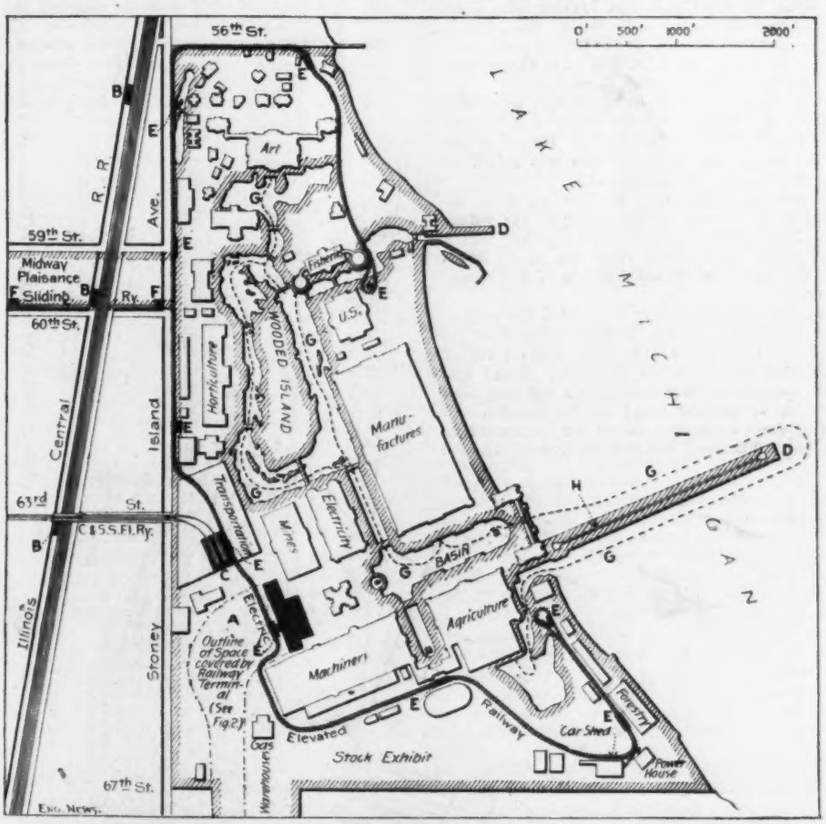


FIG. 1. MAP SHOWING GENERAL AND INTRAMURAL TRANSPORTATION SYSTEMS AT THE WORLD'S COLUMBIAN EXPOSITION.

A. Main railway terminal. B. Illinois Central R. R. C. Chicago & South Side Elevated Ry. D. Piers. E. Electric Elevated Ry. F. Sliding Ry. G. Launches. H. Movable sidewalk. The hatched outline indicates the boundary of the exposition grounds.

B. Illinois Central R. R.—This company has a right of way 200 ft. wide, with six main tracks. The tracks were originally on the street level, but in accordance with an ordinance passed by the city, the roadbed and tracks are being elevated 9 ft. above the present grade between the north line of 51st St. and the south side of 67th St. From 51st St. to 53d St. the tracks will be 18 ft. and from 53d St. to 67th St. they will be 19 ft. above city datum, and a clear headway of 18 and 19 ft. respectively is to be provided for street crossings. The embankment is of sand, 160 ft. wide at the base and 130 ft. wide at the top, and is intended for ten tracks. The streets will be crossed by iron or steel bridges, the contract for which has been awarded to the American Bridge Co., of Chicago. The abutments will be of brick or stone masonry on concrete foundations, and the bridges are to have solid floors of iron and concrete. At 62d St. the company is to construct a masonry arched subway for pedestrians, which is to be 10 ft. wide and 10 ft. high. The cost of street depressions, paving, drainage, etc., will be borne by the railway company, and the work will be done under the direction of the Commissioner of Public Works. The tracks will be equipped with the Hall block signal system, and 50 locomotives and 500 cars have been ordered specially for the exposition traffic. Cars of special design for this local traffic are being built, which will admit of being changed into fruit cars, and the drawings of these, for which we are indebted to Mr. H. Schlacks, Superintendent of Machinery, we shall publish later. It is estimated that these facilities will enable the railway to handle 21,000 passengers per hour, with trains running at five minutes headway. Mr. J. F. Wallace is Chief Engineer. The line touches the northwest corner of the grounds, crosses the Midway Plaisance and is 1,300 ft. distant from the southwest corner. There are three suburban stations within this distance, as shown on the map. The cost of all improvements, including the new city terminal station illustrated in our issue of April 28, is estimated as follows:

New city terminal station	$1,000,000
Elevating tracks	842,000
Block signals and interlocking system	842,000
Additional tracks	30,000
Platforms, fences, etc.	27,600
Locomotives; 50 at $7,000 each	350,000
Passenger cars; 500 at $3,500 each	1,750,000
Total	$4,174,000

C. Chicago & South Side Elevated Railway.—The structure and stations of this road were described and illustrated in our issues of Jan. 16 and June 2, and the engines and cars were described in our issue of Feb. 20. The engines are Forney tank engines similar to those used on the New York and Brooklyn elevated railways, but are four-cylinder Vauclain compound engines. The cars are very similar to those of the above elevated railways, but have double sliding end doors, giving a wider entrance, and the platforms and gates are somewhat wider. The company's line is to be extended southward, but a branch has been built eastward on 63d St. to a terminal station within the exposition grounds, 30 ft. above the ground, over the annex of the Transportation Building and level with the tracks of the electric elevated railway. The Illinois Central R. R. will be crossed by a bridge. In the station there will be two tracks, parallel and level with those of the intramural electric elevated railway. Three platforms will be provided, one between and one on each side of the tracks. The center platform will be 20 ft. wide by 400 ft. long, and will be used for outgoing passengers, while the platforms on either side, upon which incoming trains will discharge their passengers, will each be 12 ft. wide by 400 ft. long. Arrangements will be made by which outgoing and incoming passengers will be separated. A platform 40 ft. wide will connect with the intramural railway, and will contain exposition ticket offices. Passengers entering the exposition will pass down a flight of steps 44 ft. wide, divided from the exit staircase. At the foot of this stairway a space sufficient to contain two train loads of people has been reserved, to prevent crowding at the exposition ticket offices and turnstiles, of which there will ten each. Visitors on passing the turnstiles will find themselves facing south, opposite the main railway terminal station.

D. Steamers.—As noted in our issue of June 9, a concession has been granted to the Henry syndicate, and the World's Fair Steamship Co. organized to operate the same. It is stated that there will be four steamers, two of which will be whalebacks, having a capacity of 5,000 passengers each. They will start from a pier at Van Buren St., which will be approached by a viaduct over the railway tracks on the lake front, and small steamers will run up the river to carry passengers to the pier. At the exposition grounds the steamers will touch at both piers. The company will also run six steamers, with a capacity of 1,500 passengers each, between lake ports and the exposition piers.

The intramural transportation facilities will now be considered, but it must be said that at present these do not appear to be adequate for the probable traffic, or to sufficiently cover the grounds. After the tiring effects of walking about and looking at the exhibits, people will want some readily available means of conveyance to a restaurant, an entrance or railway station, or to the comparative quietness of the wooded island, or to another part of the grounds. The individual means of transporta-

tion, such as the cabs, electric carriages, etc., will only be used by a small percentage of the total number. The electric elevated railway will no doubt have all the traffic it can handle, but it is quite a distance from several of the main buildings and points of interest. The launches on the waterways fill in a part of the gap, and the sliding railway affords the necessary facilities for the Midway Plaisance, which is about a mile long. There is, however, a very large area of the grounds, as far as the present arrangements go, is not sufficiently well served, and the additional facilities could readily be provided by surface tracks with cars operated by horses, electricity, dummy engines or other motors, and both cars and motors would probably be willingly supplied free as exhibits by manufacturers and inventors. One of the Chicago street railway companies is now trying steam motors on its suburban lines, and engines of this kind in operation would be an interesting exhibit, while there are numerous special methods of transportation, such as wire rope railways, telferage railways (Eng. News, May 25, 1889, and July 12, 1890), the Lartigue one-rail railway, the Boynton bicycle railway (Eng. News, March 2, 1889, Jan. 10. and June 27, 1891), and others, which might very appropriately be made use of. The speed need not be at all fast, the main purpose being to enable visitors to avoid the fatigue of walking over the great area covered by the exposition grounds. As pointed out in our issue of Jan. 30, the facilities provided at the Paris Exposition, 1889, were quite inadequate, the traffic being much greater than had been estimated. It is to be hoped that ample facilities for transportation over every part of the grounds will be provided at Chicago, but, as already stated, the present means provided for do not appear to meet the requirements. Among the advisable routes for such new lines may be mentioned the following, and as they could be operated by surface cars they would not interfere with the appearance of the buildings, as an elevated structure might do: 1, a line across from the 59th St. entrance to the lake; 2, a line from the 64th St. entrance and railway terminals to the main pier; and, 3, a line along the lake front from the pier to the north part of the grounds. These lines need not be direct, but could be laid out to afford the greatest accommodation. It should be remembered that the Exposition grounds are about 7,000 ft. long from north to south, 1,700 ft. wide at the north end, and 5,000 ft. at the south end.

As to the fares, these will probably be 5 cts. in each case, but it would be a great convenience if a visitor could purchase a general ticket permitting him to travel on all or any of the lines for one day. After this review of the question of intramural transportation, we now refer briefly to the lines indicated on our map.

E. Elevated Electric Railway.—This will be a double track line carried on a timber structure and having loop terminals at the north and south ends, but as we shall shortly publish the plans and a description it is not necessary here to go into details. It will be operated by the Western Dummy Ry. Co., which is backed by the Thomson-Houston Electric Co.

F. Sliding Railway.—Along the entire length of the Midway Plaisance, nearly a mile, will be a line of the Barre hydraulic sliding or gliding railway ("chemin de fer glissant") which was a great novelty at the Paris Exposition of 1889, and was described and illustrated in our issues of Aug. 31 and Oct. 26, 1889. There will be one track for through trains and another track for trains stopping at three intermediate stations. This will be operated by the Barre Sliding Railway Co.

G. Launches.—As described in our issue of Aug. 18, a concession has been granted to the Electric Launch & Navigation Co., of New York, for operating electric launches, and another to Willard & Meeker for steam launches, on the canal, lagoon and waterways, and round the main pier to the south lake, stopping at landing stages at the main buildings and other points.

H. Movable Sidewalk.—On the main pier, 2,500 ft. long and 250 ft. wide, will be a loop line of the movable sidewalk introduced by the Multiple Speed & Traction Co., of Chicago, of which Mr. Max Schmidt is Chief Engineer. An elevated line on this system has been in operation at the grounds since last autumn, and was described and illustrated in our issue of Feb. 27, 1892. The company is to pay the exposition management $25,000 and one-third of its gross receipts, and the fare is to be 5 cts. The company has also a concession for a tower at the western end of the Midway Plaisance, up which it is proposed to operate a spiral line of the movable sidewalk.

For a part of the information given in the above article we are indebted to Mr. F. A. Peckham, of Chicago. In our next issue we shall fully illustrate and describe the intramural electric elevated railway, and in later issues we shall refer more fully to the other means of transportation.

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 315.)

Round Lake, N. Y.

Round Lake is a summer resort on the Delaware & Hudson R. R. near Saratoga Springs which has developed from a camp meeting ground with tents for shelter to a collection of cottages and other buildings which serve a permanent population of perhaps 400 and a summer population averaging 1,500, perhaps, with 7,000 or more people on the grounds during some days. The cottages and property are owned by the Round Lake Association, of which Mr. J. D. Rogers is superintendent, financial and recording secretary.

Water-works and a sewerage system were built in 1887, the sewers having been laid in the same trench as the water mains. Money to pay for the water and sewer systems was raised by subscription and lot assessment.

A restricted amount of surface water is admitted to the sewers in the center of the village only. The buildings are so close together that a single house drain serves from two to six buildings, thus reducing the total length of the sewers proper.

The only available water into which the sewage could be discharged was Round Lake, close by which the buildings are located. Some form of purification was therefore necessary. Broad irrigation was out of the question, as a sufficient area accessible by gravity could not be secured. An area of three acres was chosen for downward intermittent filtration, the location being governed

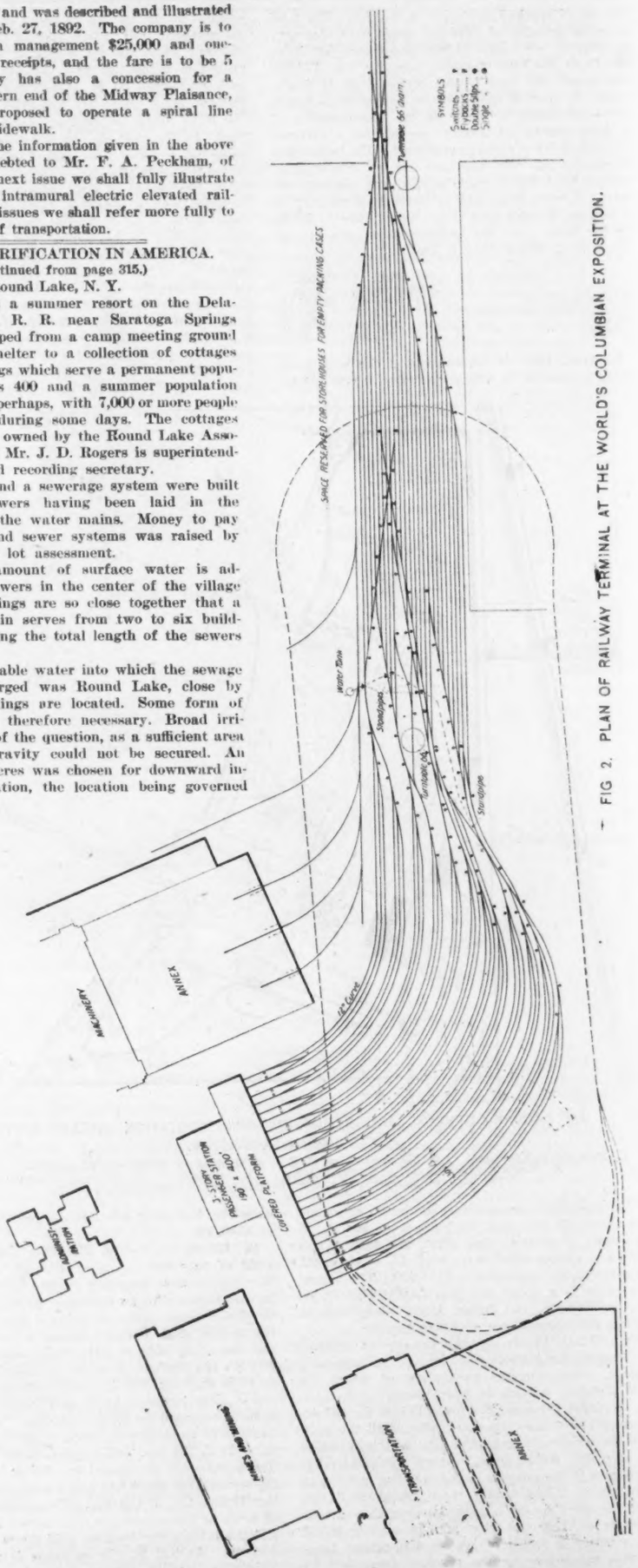


FIG 2. PLAN OF RAILWAY TERMINAL AT THE WORLD'S COLUMBIAN EXPOSITION.

by distance from the residence section rather than by suitability for the purpose. The land needed grading and underdraining. As nothing of the sort was done except to lay a few lines of tile, of course purification was not effected and a nuisance arose. It was finally decided to put in a plant for chemical treatment and the process of Mr. J. J. Powers, C. E., of Brooklyn, was adopted and has now been in use four seasons.

The process in use at Round Lake varies in minor details, only, from that in use at White Plains and Sheepshead Bay, N. Y. (Eng. News, Sept. 22, 29, and Oct. 6, 1892).

It is on a smaller scale, however, and differs in the arrangement of the tanks and movement of the sewage. A sectional plan of the purification works is shown by Fig. 33 and several vertical sections by Fig. 35.

All of the plant except the final settling tank and the sludge pumps is duplicated.

The pit A, Fig. 33, in the first compartment, is designed to retain a large part of the sludge. The screens S detain all large objects which have not settled, there being a screen or stop at the surface to intercept floating matter and a mesh screen placed across the channel. The sewage passes into the siphon chamber GB through the inverted trapped overflow O. The siphon SI removes the

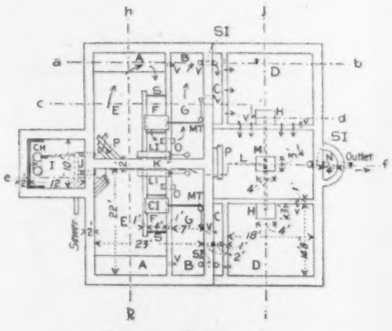


Fig. 33. Sectional Plan.

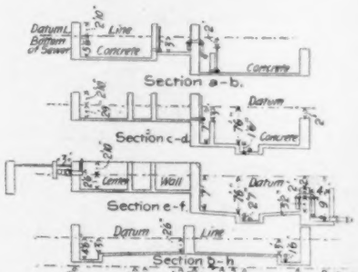


Fig. 35. Vertical Sections.

SEWAGE PURIFICATION WORKS AT ROUND LAKE, N. Y.

sewage automatically from GB to the long narrow chamber C, from which it overflows into D and again into L, from which the final siphon SI delivers it into the manhole N. From this manhole the effluent passes through a pipe to the lake, 700 or 800 ft. distant.

The lime is admitted to the sewage, as it enters the first compartment, from the left end of the lime tank LI. The perchloride of iron is admitted to the sewage before it passes through the first siphon, being discharged from the measuring tank MT, which is connected with the storage tank CI. Both the lime and perchloride of iron are discharged automatically through feed cocks worked by lever-floats, much as described in our issue of Oct. 6 under White Plains. For the lime tank a spring tripped by a cam on the lever is used instead of the revolving ports used at White Plains and Sheepshead Bay.

The chlorine generators CH are in a semi-detached building at the left ventilated by louvers.

When the precipitating tank AEFGB is cleaned, the liquid is first drawn off into the final settling tank through the valves shown in the plan, Fig. 33, after which the more fluid portion of the sludge in the pit A is, or may be, pumped into the other side for further treatment by means of the centrifugal hand pump located at P, in compartment E. Provision seems to have been made, also, for pumping from the pits H and M by centrifugal hand pumps. Such sludge as is not pumped from pit A has some absorbent mixed with it (charcoal dust has been used some of the time) after which it is shoveled into an iron bucket, lifted by a differential hoist and finally conveyed to a cart by means of an overhead trolley.

The above description is condensed and the illustrations are taken from an article by the engineer, Mr. J. L. Fitzgerald, M. Am. Soc. C. E., which appeared in "Fire and Water" for Feb. 14, 1891. It therefore describes the operations of the plant as then practiced. Mr. Fitzgerald states that for the two seasons the plant had been in operation, 1889 and 1890, it had not been necessary to remove the sludge from the pits H and M more than once or twice in the season; that it was necessary to remove the sludge from pit A every four days during the season; that chemicals were not used in winter, sedimentation being sufficient for a population of only 400; that for the two years the average cost of labor and repairs had been $200 per year and of chemicals, $150.

Aug. 26, 1892, Mr. J. D. Rogers, superintendent, wrote us that during the past season lime and perchloride of iron had been used, but that chlorine, had not been used, because a cock could not be obtained that would "hold out against the corrosion of the chemicals more than a few weeks," after which it became dangerous. The plant had been run very well without the chlorine and the cost of its operation had thus been lessened. The cost of running the plant for 1892, Mr. Rogers stated, would be about $150, including chemicals and labor, while the resulting fertilizer would be worth about $30. Doubtless no extra labor is employed to operate the plant. In fact no labor is needed except for cleaning when a laborer or two employed about the grounds can do all that is necessary in a short time.

In criticising the plant Mr. Fitzgerald, in the article referred to, states that its most apparent defects are insufficient depth and area of the tanks and lack of thorough mixture of the lime with the sewage. The latter criticism coincides with that made in our issue of Oct. 6, page 315, regarding the plant at White Plains. Mr. Fitzgerald speaks of the rapid corrosion of the valves and wearing surfaces by the chemicals and says the use of chlorine gas as a disinfectant and germicide is the chief point of merit of the plant. If the latter statement be true it seems a pity to give up the use of chlorine to save the few cocks which might possibly be spoiled in a season. It may be added that chlorine is used at White Plains, Coney Island and Sheepshead Bay, where the cocks must be as badly corroded as at Round Lake.

As to the character of the effluent, unfortunately no information is now at hand, this being the first plant described in this series which the writer has not visited.

STATISTICS SHOWING THE PROGRESS AND PROSPECTS OF RAILWAY CONSTRUCTION IN THE SOUTHWESTERN STATES.

(With Map No. 45.)

Missouri.—Existing Roads.

1. Chicago, Burlington & Quincy.—Under construction, Old Monroe to St. Louis, 42 miles.

2. Greenfield & Northern.—Under construction, Mt. Vernon to Aurora, 10 miles.

Hannibal & St. Joseph.—Projected, Barclay to Ely, 9 miles.

Kansas City & Independence Air Line.—Track laid since Jan. 1, 1892, Kansas City Suburban Belt R. R. to Independence, 5.6 miles.

3. Kansas City, Nevada & Ft. Smith.—Track laid in 1891, Ameret to Hume, 12 miles. Under construction, Hume to Clayton, 18 miles. Located, Clayton to Pittsburg, Kan., 38 miles.

Kansas City, Osceola & Southern.—Track laid since Jan. 1, 1892, between Coburg, and Koche Junc, 1 mile.

Kansas City Suburban Belt.—Track laid since Jan. 1, 1892, in Kansas City, 2¼ miles. Under construction, in Kansas City, 1 mile. Surveyed, Kaw River to Argentine, 4 miles; Kaw River to Quindaro, 2 miles.

4. Mississippi River & Bonne Terre.—Track laid in 1891, Bonne Terre to Doe Run, 15.1 miles.

5. Missouri Kansas & Eastern.—Track laid since Jan. 1, 1892, Hamburg, west 25 miles. Under construction, to Franklin, 110 miles. Surveyed, St. Charles to Portage des Sioux, 12 miles.

6. Missouri Pacific.—Track laid since Jan. 1, 1892, Webb City to Scotland, 4.8 miles. Surveyed, Boonville to Scotts, 40 miles.

7. Montgomery Western.—Track laid in 1891, Montgomery to quarries, 2½ miles.

St. Louis & Hannibal.—Track laid since Jan. 1, 1892, Perry to New London, 18 miles. Under construction, Oakwood to Hannibal, 3 miles.

8. St. Louis, Cape Girardeau & Ft. Smith.—Surveyed, Puxico to Poplar Bluff, 20 miles.

Projects and Surveys.

9. Kansas City, Eldorado & Southern.—Projected, Rich Hill to Eldorado, 30 miles. T. H. Anderson, Nevada, Mo.

10. Springfield, Sedalia, Marshall & Northern.—Surveyed, Springfield to Miami, 150 miles. Ch. Engr., A. M. Nelson, Springfield, Mo.

Total.—Track laid in 1891, 29.6 miles. Track laid since Jan. 1, 1892, 57 miles. In process of construction, 184 miles. Surveyed or under survey, 248 miles. Projects of some promise, 39 miles.

Indian Territory.—Existing Roads.

11. Chicago, Rock Island & Pacific.—Track laid since Jan. 1, 1892, Minco to the Red River, 104 miles.

12. Choctaw Coal & Ry. Co.—Track laid in 1891, extension toward Oklahoma City, 11 miles. Track laid since Jan. 1, 1892, extension to Oklahoma City, 12 miles. Surveyed, South McAlister to Oklahoma City, 80 miles.

Total.—Track laid in 1891, 11 miles. Track laid since Jan. 1, 1892, 116 miles. Surveyed or under survey, 80 miles.

Arkansas.—Existing Roads.

13. Arkansas Midland.—Projected, Pine City to Indian Bay, 12 miles.

14. Eureka Springs.—Under survey, Eureka Springs to Harrison, 50 miles. Projected, Harrison to Bald Knob, 110 miles.

15. Ft. Smith, Paris & Dardanelle.—Projected, end of track to Dardanelle, 70 miles.

16. Hope & Lewisville.—Track laid in 1891, Lewisville, toward Hope, 7 miles. Under construction, extension to Hope, 17 miles. Pres., John A. Roberts, New Lewisville.

17. Kansas City, Arkansas & New Orleans.—Under contract, Beebe to Stuttgart, Ark., 47 miles. Secy., T. F. Lingiser, 18 Broadway, New York City.

18. Kansas City, Ft. Smith & Southern.—Projected, Sulphur Springs to Ft. Smith, 107 miles.

19. Mississippi & Little Rock.—Track laid in 1891, 14 miles west of Aurich west, 24 miles. Partly graded; extension to Argenta, 28 miles.

6. Missouri Pacific.—Track laid in 1891, Camden to Eldorado, 32½ miles.

20. Prescott & Northwestern.—Track laid in 1891, Prescott to near Wallaceburg, 7 miles. Surveyed, extension to Wolf Creek, 16 miles.

21. St. Louis Southwestern.—Track laid in 1891, at Argenta, 1½ miles.

22. Southern Arkansas.—Partly graded, Dry Run to Hampton, 23 miles. Ch. Eng., John Brantley, Dry Run.

23. Springfield, Yellville & White River.—Under construction, mouth of Buffalo River to Georges' Creek, 20 miles. Pres., Ed. H. Webster; Ch. Engr., D. W. Pike; both of Kansas City, Mo.

24. Stuttgart & Arkansas River.—Track laid since Jan. 1, 1892, De Witt south 5 miles. Graded, extension toward Pendleton, 11 miles.

25. Texarkana & Ft. Smith.—Track laid in 1891, Tuilock to Ashdown, 10 miles. Track laid since Jan. 1, 1892, Ashdown to Wilton, 6 miles. Located, Wilton to Lockesburg, 15 miles.

26. Ultima Thule, Arkadelphia & Mississippi River.—Surveyed, Dalark to Millville, 25 miles. N. S. Woods, Arkadelphia.

Projects and Surveys.

27. Arkansas Southern.—Projected, Eldorado south 13 miles. Pres., C. C. Henderson, Arkadelphia, Secy., D. E. Armstrong, Eldorado.

28. Hoxie & Pocahontas.—Surveyed, Hoxie to the Missouri line, 35 miles. Pres., Wm. D. Gentry, 10 Washington St., Chicago.

29. Pine Bluff, Monroe & New Orleans.—Surveyed, Swan Lake to Bayou Meto, 8 miles.

30. Ravenden Springs & North Arkansas.—Located, Ravenden to Ravenden Springs, 9 miles. President, John B. Jones, Little Rock. Ch. Engr., R. L. Dougherty, Springfield, Mo.

Total.—Track laid in 1891, 82 miles. Track laid since Jan. 1, 1892, 11 miles. In process of construction, 114 miles. Surveyed or under survey, 158 miles. Projects of some promise, 312 miles.

Louisiana.—Existing Roads.

East Louisiana.—Track laid since Jan. 1892, Abita Springs to Mandeville, 10 miles.

Illinois Central.—Under survey, Tangipahoa to Clinton, 30 miles.

31. Kansas City, Watkins & Gulf.—Track laid in 1891, ten miles north of Lake Charles, to 60 miles north of Lake Charles, 50 miles. Track laid since Jan. 1, 1892, Oakdale to Alexandria, 40 miles. Surveyed, Bon Ami to the Gulf of Mexico, 34 miles.

32. Louisiana Nickel Plate.—Track laid in 1891, Velma to Allentown, 2½ miles. Tracklaying in progress, Allendale to Bellevue, 12 miles. About 5 miles laid.

Louisville, New Orleans & Texas.—Track laid in 1891, Lutcher to mills, 6 miles.

6. Missouri Pacific.—Track laid in 1891, Riverton to Alexandria, 72½ miles. Projected, Eldorado to Alexandria, 125 miles.

33. Natchitoches.—Under construction, Natchitoches to Red River, 4 miles.

34. New Orleans & Northwestern.—Partly graded, Rayville to Bastrop, 25 miles. Under construction, Bastrop to Collins, 10 miles. Ch. Engr. and Rec., W. Dunbar Jenkins, Natchez, Miss.

New Orleans, Ft. Jackson & Grand Isle.—Track laid in 1891, Socala to Buras and Grand Bayou, 21 miles. Surveyed, Grand Bayou to Grand Isle, 8 miles.

Southern Pacific.—Under construction, 26 miles south of New Iberia to Abbeville, 16¼ miles.

Total.—Track laid in 1891, 151 miles. Track laid since Jan. 1, 1892, 55 miles. In process of construction, 62 miles. Surveyed or under survey, 72 miles. Projects of some promise, 125 miles.

Texas.—Existing Roads.

Aransas Harbor Terminal.—Partly graded, Aransas Harbor to Mustang Island, 9¾ miles. Ch. Engr., D. D. Matthews, Dallas.

Austin & Northwestern.—Track laid since Jan. 1, 1892, Fairland to Llano, 29.4 miles.

Bonham Rapid Transit.—Track laid in 1891, at Bonham, 3 miles.

11. Chicago, Rock Island & Pacific.—Graded Red River to Bowie, 24 miles.

35. Denison, Bonham & New Orleans.—Partly graded, Denison to Bonham, 28 miles.

36. Ft. Worth & Rio Grande.—Track laid in 1891, Comanche to Brownwood, 33½ miles; at Ft. Worth, 2½ miles. Projected, Brownwood to Brady, 44 miles.

Galveston, La Porte & Northern.—Graded, La Porte to Harrisburg, 14 miles. Ch. Engr., Woodbridge, La Porte, Tex.

Georgetown & Granger.—Partly graded, Georgetown to Granger, 15 miles.

37. Hearne & Brazos Valley.—Track laid in 1891, H. & B. V. Junc. to Mumford, 9 miles. Track laid, since Jan. 1, 1892, Mumford to Mosley's Ferry, 5½ miles.

38. Missouri, Kansas & Texas.—Track laid in 1891, Milford to Hillsboro, 14.8 miles. Track laid since Jan. 1, 1892, Smithville to Lockhart, 36 miles. Under construction, Boggy Tank to Sealy, 29 miles. Projected, Seymour to Benjamin, 30 miles.

North Galveston, Houston & Kansas City.—Under construction, North Galveston to Virginia Point, 16 miles.

Pan American.—Track laid since Jan. 1, 1892, Victoria to Guadalupe River, 10 miles. Located, Guadalupe River to Refugio, 33 miles. Surveyed, Refugio to Brownsville, 181 miles.

39. Red River & Southwestern.—Partly graded, Henrietta to Archer City, 30 miles.

40. San Antonio & Aransas Pass.—Track laid in 1891, Lexington to Lott, 57.9 miles.

41. Sherman, Denison & Dallas.—Projected, Sherman to Dallas, 80 miles. Ch. Engr., Geo. M. Jarvis, Denison.

South Galveston & Gulf Shore.—Track laid since Jan. 1, 1892, in city of Galveston, 4 miles. Pres., M. F. Mott, Galveston.

42. Texas Central.—Surveyed, Roberts to Greenville, 18 miles; Dublin to Thurber, 32 miles. Projected, Albany to Anson, 40 miles.

Texas, Louisiana & Eastern.—Track laid in 1891, Conroe east, 8 miles. Under construction, extension to Ironwood, 32 miles.

Velasco Terminal.—Track laid in 1891, Velasco to Oyster Creek, 6 miles. Track laid since Jan. 1, 1892, Oyster Creek to Chenango Junc., 15 miles; Velasco to Surfside, 3½ miles.

Projects and Surveys.

43. Bridgeport & Decatur.—Located, Decatur to Bridgeport, 15 miles. Ch. Engr., C. E. Moore, Decatur.

Houston Belt.—Located, belt line at Houston, Tex., 15 miles. Pres., R. H. Harrison, Houston.

Rockport & Harbor Island.—Surveyed, Rockport to Harbor Island, 10 miles. Pres., J. H. Traylor, Dallas.

44. Trinity, Cameron & Western.—Surveyed, Trinity to Granger, 113 miles. Pres., J. M. Hefly; Secy., M. J. Moore; both of Trinity.

Velasco Northern.—Surveyed, Velasco to Rosenburg Junc., 60 miles. Ch. Engr., J. H. Berard, Velasco.

Total.—Track laid in 1891, 135 miles. Track laid since Jan. 1, 1892, 103 miles. In process of construction, 198 miles. Surveyed or under survey, 477 miles. Projects of some promise, 194 miles.

Illinois.—Existing Roads.

(Lines within limits of map only.)

45. Centralia & Chester.—Track laid in 1891, Oakdale to Nashville, 8¾ miles. Track laid since Jan. 1, 1892, Nashville toward Centralia, 11 miles. Graded to Centralia, 11 miles. Projected, Centralia to Altamont, 76 miles; Sparta to Chester, 20 miles.

46. Chicago & Eastern Illinois.—Track laid in 1891, Tuscola to Shelbyville, 41 miles. Surveyed, Shelbyville to Herrick, 15 miles.

47. Chicago & New Orleans.—Surveyed, Farina to Paducah, 130 miles.

48. St. Louis, Alton & Springfield.—Projected, Alton to East St. Louis, 20 miles.

49. St. Louis, Grand Tower & Southern.—Surveyed, East St. Louis to Grand Tower, 60 miles. Ch. Engr., Clinton F. Stephens, St. Louis.

50. St. Louis, Collinsville & Carondelet.—Surveyed, Madison to East Carondelet, 50 miles. Pres., A. M. Powell, Collinsville.

51. Wabash, Chester & Western.—Under construction, Tamaro to Mt. Vernon, 22 miles.

Projects and Surveys.

52. Flora & Sailor Springs.—Surveyed, Flora to Sailor Springs, 10 miles.

53. Little Wabash.—Projected, Effingham to Carmi, 75 miles.

54. Terre Haute, Sailor Springs & Chester.—Projected, Terre Haute, Ind., to Tamaroa, 135 miles.

Total.—Track laid in 1891, 50 miles. Track laid since Jan. 1, 1892, 11 miles. In process of construction, 33 miles. Surveyed or under survey, 265 miles. Projects of some promise, 326 miles.

A NOVEL BOILER SETTING.

The accompanying drawings illustrate the furnaces and settings adopted for four steam boilers recently installed at the Wellman Iron and Steel Works, Thurlow, Pa. The boilers furnish steam to the blowing engines supplying air to the Bessemer converters. The arrangement of the furnaces and setting was devised by Mr. S. T. Wellman, M. Am. Soc. M. E., President of the company. The boilers have plain cylindrical shells 90 ins. in diameter and 15 ft. long. They are not inclosed in brick work but are protected from radiation by a non-conducting covering 2½ ins. thick.

The chief points of interest in connection with the plant are the use of a forced draft, the detaching of the furnace from the boiler, and the passing of the entering air over the top and sides of the furnace to the ash pit, thus warming it somewhat before it reaches the fire, and saving heat which would otherwise be radiated into the boiler room. It is well recognized that a detached furnace enables a very perfect combustion of the fuel to take place, its temperature being higher than that of a furnace part of whose walls form the heating surface of the boiler. It has been contended, however, that such furnaces were not economical of fuel on account of the radiation from their highly heated walls. In the plant illustrated this difficulty seems to have been overcome, as the evaporative record of the boilers is an excellent one. We understand also that the boiler room is kept quite cool and comfortable.

Among other noticeable points in the design is the protection of the tube plate from the direct heat of the furnace and the impact of sparks and cinders, by the use of a fire brick arch located about 2 ft. back of the tube plate. Each boiler has an independent stack, and in the center of each stack is placed a 3-in. steam pipe. To clean the tubes live steam is blown through this pipe and the powerful draft thus produced sweeps out any dust which may have collected from the anthracite rice used as fuel. The great advantage claimed for the plant is that repairs are very small compared with boilers with internal furnaces or those with ordinary setting.

The total heating surface of each boiler is 2,300 sq. ft. and its grate surface is 64 sq. ft., a ratio of 36 to 1. With a forced draft of 1 oz. pressure about 13 lbs. of coal per sq. ft. of grate surface is burned per hour. Tests made on one of the boilers last winter showed the following results, anthracite rice being the fuel used in all cases:

The following itemized statement of the cost of the four boilers with chimneys complete ready for operation has been furnished us by Mr. Wellman.

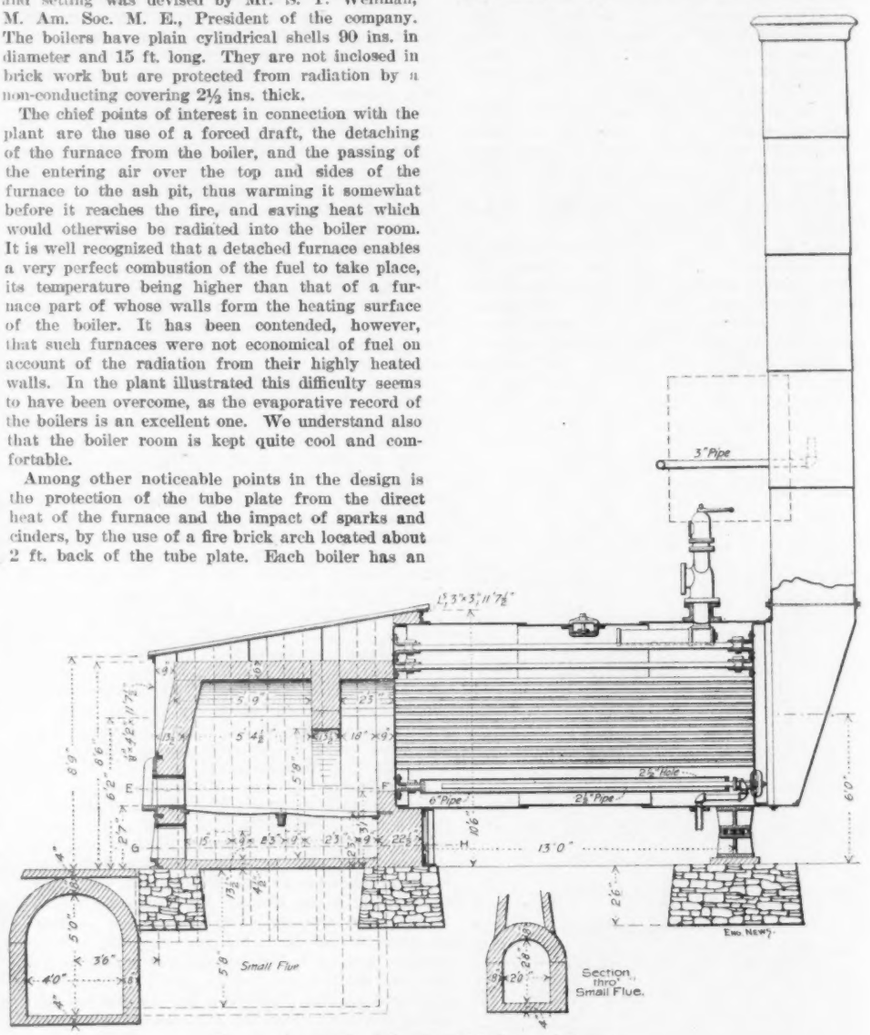


Fig. 1. Longitudinal Section of Boiler and Furnace.

BOILER SETTING IN USE IN BESSEMER BOILER HOUSE OF THE WELLMAN IRON AND STEEL CO. THURLOW, PA. DESIGNED BY S. T. WELLMAN, M. AM. SOC. C. E.

Results of Tests of Wellman Boiler.

Coal used in all tests.	No. 1. Anthracite rice.	No. 2. Anthracite rice.	No. 3. Anthracite rice.	Totals and averages.
Duration of test, hours	124.25	72.5	58	254.75
Coal consumed, lbs.	100,468	59,305	49,695	209,468
Water evaporated, lbs.	832,490	471,410	391,170	1,695,070
Coal per hour, lbs.	808.6	818	857	828
Coal per hour per sq. ft. grate, lbs	12.6	12.8	13.4	12.9
Water per hour, lbs	6,700	6,503	6,744	6,649
Water per hour per sq. ft. heating surface	2.9	2.8	2.9	2.9
Average boiler pressure, lbs.	85	95	100	93
Average temperature of feed water	119.4°	129°	125°	124.5°
Average temperature of escaping gases	325°	425°	480°	410°
Number of times of cleaning fires	28	14	12	54
Water per lb. of coal, lbs.	8.28	7.94	7.87	8.03
Water per lb. of coal from and at 212°, lbs.	9.36	8.89	8.89	9.05

Boilers	$5,120.00
Stacks	900.00
Blower	200.00
Engine	400.00
Plates	341.98
Castings	887.70
Safety Valves, Pipes, Connections, etc.	457.38
Indicators	803.41
Labor	1,308.55
Boiler Covering	396.83
Total	$10,815.85

This indicates a first cost of less than $10 per horse-power, a figure which taken in connection with the excellent fuel economy shown is certainly very creditable to the designer of the plant.

IRRIGATION BY ARTESIAN WELLS.*

The total number of artesian wells used for irrigation during the census year has been ascertained to be 3,930, furnishing water for 51,896 acres, or 1.43% of the total area irrigated. The total number of artesian wells upon farms in June, 1890, in the 14 states and territories forming the western part of the United States was 8,097. The average depth was 210.41 ft.; the average cost, $245.58, and the average discharge,

* From Extra Census Bulletin No. 23, "Irrigation in the Western United States."

54.43 gallons per minute, irrigating 13.21 acres per well. Out of the total number of 8,097 artesian wells complete statistics were obtained concerning 2,971, or 36.69%. From this latter number of wells, fairly distributed through each state and county, averages have been drawn, which, when applied to the entire number, give the results shown in Table 1:

Table 1.—Artesian Wells on Farms in June, 1890.

State and territories.	Total.	Av. depth, ft.	Av. cost.	Av. discharge, gal. per min.	Wells used in irrigation. P. c. of all wells.	Wells used in irrigation. Computed No.	Acres irrigated by wells. Per well.	Acres irrigated by wells. Total.
Cal.....	3,210	248	$425	164	64.17	2,060	18.63	38,378
Colo....	596	251	221	39	57.85	345	18.01	6,213
Idaho....	28	83	53	11	50.00	14	13.21	185
Kan....	59	202	175	44	41.37	24	13.71	329
Mont...	14	366	473	28	42.85	6	3.00	18
Neb.....	91	247	173	13	7.40	7	1.00	7
Nev....	33	215	607	6	60.00	20	1.00	20
N. Dak.	461	196	265	21	2.17	10	2.00	20
Ore....	6	70	250	15	50.00	3	4.00	12
S. Dak..	527	216	158	51	13.46	71	6.68	474
Tex.....	534	202	359	19	27.32	146	3.00	438
Utah....	2,524	146	78	26	48.49	1,224	4.74	5,802
Wash...	9	127	312	89	.....	.....	.....	.....
Wyo....	5	210	456	8	.....	.....	.....	.....
Total.	8,097	210	246	54	48.54	3,930	13.21	51,896

In measurements of flowing water several units are in use, depending largely upon the amount of water and the connection in which the latter is discussed. For engineering purposes in the United States the unit most widely employed in measurements of rivers and streams is the second-foot. The quantities of water discharged by artesian wells are, however, generally so small that the use of the second-foot as a unit is inconvenient on account of the fractions involved. The flow is therefore usually expressed in gallons per minute, the gallon being often employed by engineers in computations of municipal water supply. A cubic foot equals 7.48052 gallons, and therefore 1 cu. ft. per second, or second-foot, equals 448,831 gallons per minute. Conversely, 1 gallon per minute is equivalent to 0.002228 sec.-ft.

The average discharge of the artesian wells, 54.43 gallons per minute, is equivalent to 0.121 sec.-ft. At this rate the flow from all the 8,097 wells was 979.74 sec.-ft. Comparing the average number of acres irrigated, viz., 13.21, with the average discharge of water, 0.121 sec.-ft., it appears that at this rate 1 sec.-ft. would irrigate 109.17 acres. In other words the duty of the water from these artesian wells under the assumptions made above was 109.17 acres per sec.-ft.

At an average expense of $245.58 per well, the discharge given cost at the rate of $4.51 per minute-gallon, or $2,025 per sec.-ft. Assuming that the duty of water as deduced above is 109.17 acres per sec.-ft., the average cost of irrigating an acre has been $18.55. As shown by Table 1 (of the Bulletin), the average cost of irrigation throughout the entire country was $8.15 per acre, or 43.93% of the cost by artesian wells in cases where these have been successful.

An artesian well discharging at the rate of 1-10 cu. ft. per sec., or 44.88 gallons per minute, will in one day cover an acre of ground with water to the depth of 0.198 ft., provided that none escapes by evaporation or seepage. Stating the same fact in another way, a well flowing at this rate will cover nearly two-tenths of an acre to the depth of 1 ft., and in a month of 30 days will cover 5.95 acres to a like depth. Thus, by storing the water, if it were possible to do so without loss, large quantities could be obtained from comparatively small wells. Unfortunately, however, the loss from ordinary earthern reservoirs is so great that the smaller wells can hardly do more than saturate the ground in their immediate vicinity, little or no water accumulating on the surface unless this has been made almost completely impervious.

In most of the states and territories the area irrigated by flowing wells is almost insignificant; in the state of California alone does the ratio rise above 1%. Table 2 shows the total area irrigated, the number of acres watered by artesian wells, and the percentage of the latter to the former:

Table 2.—Percentage of Total Area of Irrigated Land Irrigated by Water From Artesian Wells.

States and territories.	Area irrigated in 1889, acres.	Area irrigated by artesian wells in 1889, acres.	Per cent.
Arizona	65,821	.....	.....
California	1,004,233	38,378	3.822
Colorado	890,735	6,213	0.698
Idaho	217,005	185	0.085
Kansas	20,818	329	1.580
Montana	350,582	18	0.005
Nebraska	11,744	7	0.060
Nevada	224,403	20	0.009
New Mexico	91,745	.....	.....
North Dakota	445	20	4.494
Oregon	177,944	12	0.007
South Dakota	15,717	474	3.016
Texas	18,241	438	2.401
Utah	263,473	5,802	2.202
Washington	48,790	.....	.....
Wyoming	229,676	.....	.....
Total	3,631,381	51,896	1.429

CHICAGO BUILDINGS AND FOUNDATIONS.*

Let us consider the existing conditions in the city of Chicago which control the character of its great buildings. There are no special difficulties which have to be overcome in the construction of ordinary light ones.

The main business of the city took up its residence at a very early day on the narrow strip of land lying between the south branch of the Chicago River and Lake Michigan, and it has clung persistently to the northern end of this strip, only extending southward as its increasing volume demanded more space. This has been mainly due to the fact that the territory under consideration is most easy of access to the people living in the three divisions of the city. As a consequence of the concentration of business on this small area, property lying within it has always been very valuable as compared with that exterior to it. This fact has made it a great object to owners to build very high buildings on their lots.

And in the very "nick of time" the elevator put in its appearance to make a sixteen-story building with it more convenient than a four-story one had been without it. And so it is practicable to get four times the rentable floor space on a given area of ground surface than could have been had with the old-fashioned four-story buildings. The rental of offices in the business district amounts to about $1.50 per sq. ft. per annum; landlords are naturally anxious to build many-storied buildings, and to economize floor space to the last degree; and each new building is planned higher than its predecessor, and even some old buildings put on airs and new stories. Up went the eyebrows of our good citizens at these "Towers of Babel," and up went the citizens themselves into them—with some misgivings at first lest they should be dropped through one or two hundred feet by the breaking of a cable, or by failure of some part of the hoisting apparatus; but these fears soon disappeared, as scarcely any accidents of this kind occur. And so convenience sanctions the tall building which necessity demands—and it has come to stay.

But a tall building, if of the same construction as a low one, will be proportionately heavier. And here comes the first troublesome condition of our problem.

The city stands on a low, flat plane; the highest point in its original plat was but 5 ft. above high water

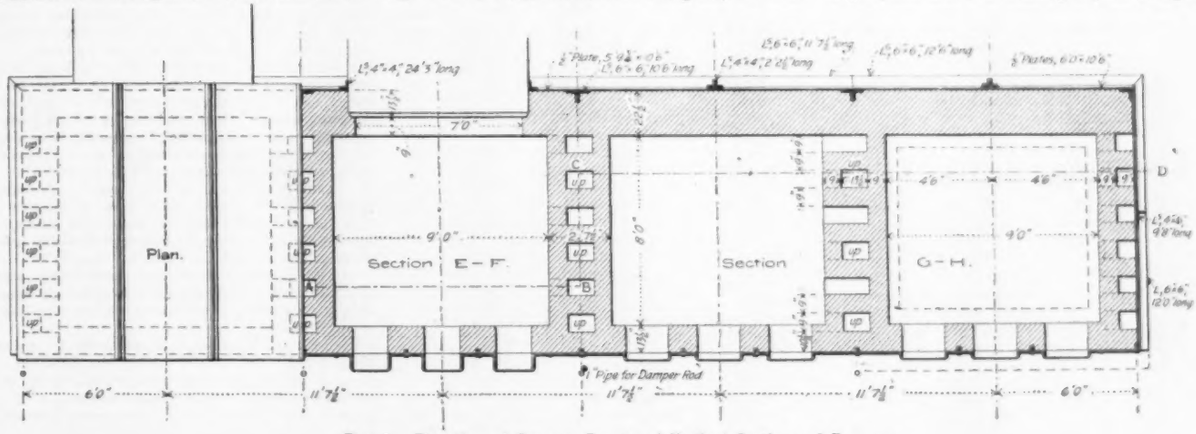


Fig. 2. Elevation of Furnace Front and Vertical Sections of Furnace.

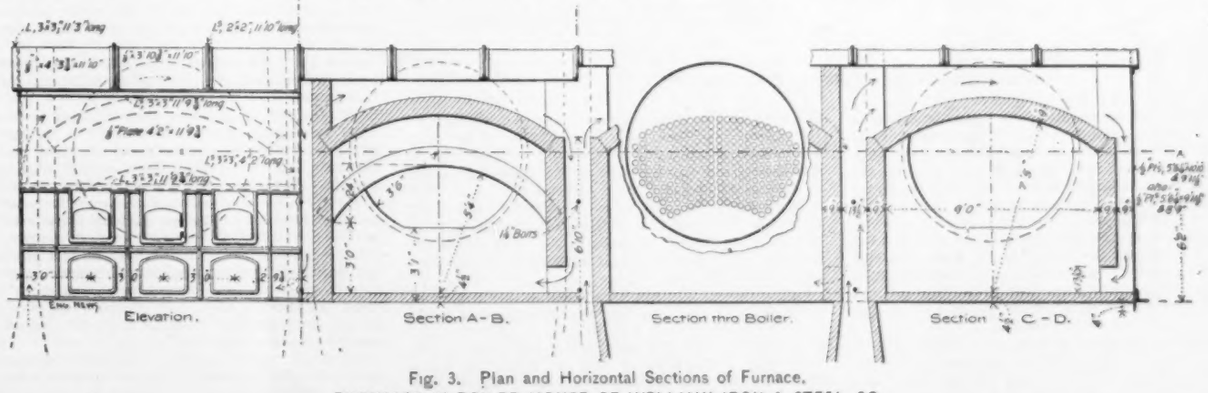


Fig. 3. Plan and Horizontal Sections of Furnace.

FURNACES IN BOILER HOUSE OF WELLMAN IRON & STEEL CO.

* An address on "The Sooy Smith System of Building Construction for Chicago" (somewhat abridged). Delivered at the University of Illinois, March 31, 1892, by Gen. William Sooy Smith, and published in the "Technograph" of that institution; with sundry discussions brought out by that paper.

level in the lake. The grade of the streets has been raised, however, until the curb lines are now about 14 ft. above city datum or mean low water surface. The material underlying the surface is clay, varying in consistency from firm to very soft at different points and different depths, these variations occurring often within the area covered by a single building.

Its sustaining power, as determined by many tests that I have made with actual loads, is from 2,500 lbs. to 4,000 lbs. per sq. ft. It is the common practice of Chicago architects to load the soil at the rate of 3,000 lbs. per sq. ft. Under these loads a small initial settlement takes place within a few hours, due to compacting of the soil at the surface upon which the load rests, and in part perhaps from displacement of water from the earth immediately adjacent to this surface by pressure of the loads applied.

After this no further measurable settlement takes place during the time (some weeks) covered by my longest experiment. Experience with heavy buildings shows, however, that in the course of months and years they do continue to settle when the loads they exert upon the soil do not exceed the limits stated. Experience also shows that while the initial settlements under a given load may be uniform throughout the area covered by a building, the progressive ones may so differ eventually as to cause serious cracks and demoralization in the structure.

The slow progressive settlements result from the squeezing out of the water from the earth, as was clearly seen while the wells were sunk under the stage whole ground plan of the building. Unfortunately, while the loads may be made equal, the strength of the soil to sustain them in many instances varies considerably, and unequal and troublesome settlements take place. And now we are face to face with the second great difficulty with which we have to contend.

In view of the great height and consequent great weight of our principal buildings, it is important that materials should be used in their construction which unite in the highest degree lightness and strength with the other qualities of good building materials. And so steel naturally came to the front. As a great building now goes up in Chicago, a gaunt skeleton of steel first rises, and this is gradually clothed from story to story with stone and brick, tile and mortar.

But with each change of temperature, the steel skeleton expands and contracts, apparently striving to tear off its clothing, especially if exposed to such heat as results from the burning of great quantities of combustible materials in itself or in an adjacent building, and this last danger may threaten even an office building, which itself contains very little combustible material, and in spite of the means usually employed to protect the metal from heat by the tile covering put upon it; for this covering will become so hot as to conduct enough heat to the steel to expand it, and crack off at the tile coverings. This has happened already—notably at the burning of the Tribune Building, in Minneapolis, about two years ago, which resulted in its utter destruction.

There may be steel buildings in which the fireproofing

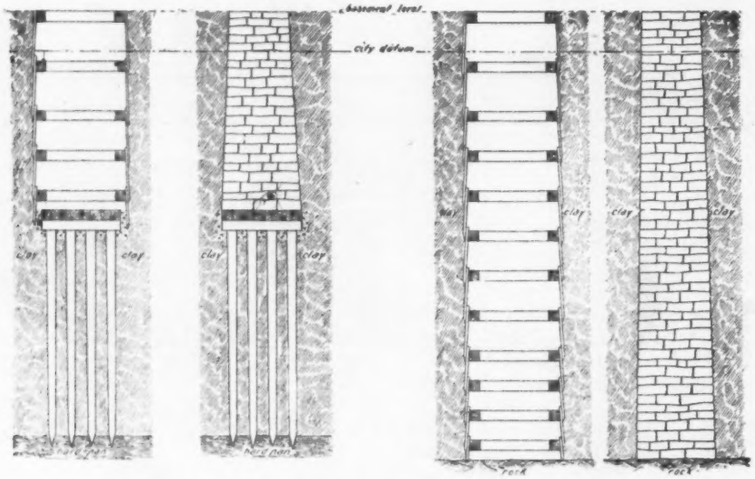


Fig. 1. Fig. 2.

FOUNDATIONS FOR COLUMNS IN CHICAGO BUILDINGS.

of the Auditorium for receiving the hydraulic cylinders used for operating the scenery. I sank these wells after the adjacent walls of the building were built. Some of them went to a depth of 24 ft. below the footings of the foundations and only 4½ ft. from them. The weights resting on the soil amounted to 30 lbs. per sq. in., or 4,320 lbs. per sq. ft.

I had made the borings and tests of the soil and knew the nature of the materials at different depths well. The clay that had been of the usual character when the borings were made had all become compact and hard, and contained very little water—none had to be pumped while the wells were dug.

Extraordinary precautions were taken to prevent the movement of the earth around the wells, as such movement might have caused serious settlements of the walls. Strong steel rings were used, and tongued and grooved sheathing was driven outside these rings, and kept well in advance of the excavations as this proceeded. We got the wells down without the slipping of a spoonful of earth outside of them, and this without the difficulty anticipated, owing to the betterment that had taken place in the material as described.

The usual method of designing and building foundations in Chicago was very clearly explained in a recent address delivered to you by one of our best known architects, Mr. W. L. B. Jenney. These foundations are detached and independent of each other, and of such area in plan as to equalize the load per square foot which the underlying material has to sustain throughout all parts of the building, and to keep this load within safe limits. Thus far, this has been thought to be the best that could be done to secure buildings against unequal or excessive settlements.

For greater safety another of our very ablest and most distinguished architects, Henry Ives Cobb, designed the foundation of the Owings Building, making it one strong platform of steel and concrete covering the has been so well done that they will pass through an ordinary fire without such failure. But if the steel becomes even moderately heated, its stiffness will be diminished, and the strength of the upright members so reduced as to cause them to bend and yield. This is more likely to occur as the horizontal beams and girders at the same time will expand (unequally from the different degrees of temperature) and throw the posts out of vertical and into buckling positions. This is the third difficulty.

Under these circumstances, if floors were built of perfectly rigid materials the unequal settlement would crack them into pieces and ruin them. The elasticity of the steel beams now used in the floor systems partially obviate this difficulty, but not wholly; as many floors in which they are employed, notably those of the post office and custom house building, are badly demoralized by unequal settlements. Here is the fourth difficulty, and our present system does not seem to provide for it satisfactorily.

Now, supposing that we have succeeded in overcoming the great difficulties already pointed out, if steel and iron are used as principal parts of our buildings and these parts are not perfectly protected from corrosion, the building will be comparatively short-lived.

There are many imperfections in minor details, such as weakness of brackets and their fastenings, want of proper provision for resistance to strains resulting from wind pressure, etc., which we need not here describe or discuss. They are only alluded to because they are liable to occur in the class of buildings we have under consideration, unless they are guarded against.

Having thus considered the difficulties of our problem, let us endeavor to discover proper remedies for them.

First, we must, if practicable, secure an unyielding, instead of a yielding foundation.

The soft materials described are underlaid by rock at a depth of from 60 ft. to 100 ft. in the central and northern parts of the city near the lake. The rock rises to the southward and westward, coming to the surface at points in the western and southwestern parts of the city. Wherever it is practicable, the foundations of heavy buildings should rest upon the rock, or upon the hard pan immediately overlying it.

As timber is everlasting under water, excavations can be made for foundations well below water surface in the lake, and piles can be driven in the bottom of such excavation down to the rock, or into the hard pan immediately overlying it. These piles should be cut off at a level below that of any conceivable deep drainage system that may become desirable, or necessary in the city (say 15 ft. below city datum). Platforms of timber and concrete should be laid on the piles, and on these platforms pillars or walls of masonry or concrete should be carried up to the level of the basements, or sub-basements of buildings. In this way sub-basements could be provided in which the machinery necessary for operating elevators and electric lights, and for heating, and all other purposes, could be accommodated, leaving the first basements free for other uses, and thus making them rentable at high rates. The enhancement of the value of property consequent upon this increase of rents would far more than pay for the deep system of drainage, which the city of Chicago so much needs.

Where rock is found within easy reach, the excavations can be made to the rock, and the masonry or concrete construction can be carried up from the bedrock without the use of piles. And so we may put unyielding and imperishable foundations under our buildings, and avoid all the danger and losses which may result from placing very high and heavy structures on comparatively soft and compressible materials.

A pile driven at the bottom of a pit 30 ft. deep, and well into hard pan or to the rock, where this is within reach, can be safely relied upon to sustain from 30 to 40 gross tons.* When the weights of all parts of a building have been carefully computed, it is a simple matter to determine the number of piles required to sustain these loads. And in cases in which the rock is within easy reach by wells, say at a depth not exceeding 60 ft., they can be sunk to the rock and a pillar or column of rubble masonry, or concrete, can be carried up to the level of the basement or sub-basement floor, as shown in Figs. 1 and 2.

Careful estimates show that these foundations will cost less than those which are now generally employed, namely, platforms of steel and concrete, resting upon compressible soil.

Our safe and accomplished architects, Adler and Sullivan, have taken a long step in the direction of the plan of foundations above recommended, in causing piles to be driven under the foundations of the German Theater they are now building on Randolph, between Dearborn and Clark streets.

The foundation of the County Building in Chicago also rests on the piles; but these were so small and so carelessly driven that they are of nowhere near full value.

Some elevators and warehouses, the shot tower and other structures, rest upon pile foundations simply, but I know of no instance in which wells or pits have been sunk and piles driven in the bottom of them in order to reach rock or its equivalent, or to place the pile heads, when they have been sawed off and the platforms built on them, below the level of perpetual moisture when the deep drainage which the city so sorely needs has been secured. And there is no instance in which foundations of stone masonry or concrete have been carried down, as here suggested, to the bed rock. By the construction of foundations of this character, we dispose of our first, second and fourth difficulties, namely, that of placing very heavy buildings on a weak soil, and the unequal settlements of different parts of the same building, resulting from the unequal sustaining power of the same soil.

The third difficulty, resulting from the expansions and contractions of the metals employed in the construction of tall buildings, may be obviated by protecting these metals absolutely from any considerable change in temperature, or by throwing out the metals altogether and substituting tile, brick and stone, as far as may be practicable. As the weights to be borne by the vertical members of buildings, such as we have described, are very great, it becomes necessary to use materials and modes of construction which will make these vertical members as small as may be in cross-section, consistently with the loads they have to carry, in order to economize floor space, which is the revenue-producing part of the building.

Now, first class cut stone masonry, laid in hydraulic cement mortar, has about one-fourth the compressive resistance of the stone of which it is composed. If, therefore, the stones themselves can be placed in abso-

* By the formula

$$\frac{2\,wh}{s+1}$$

which has been suggested by this journal for the safe load of piles, a ton hammer falling 30 ft. with ½-in. penetration, is safe for $60 \div 1.5 = 40$ tons; with 1-in. penetration, for 30 tons.—Ed.

lute contact, without the interposition of mortar, it is fair to presume that much greater compressive resistance of the material would be obtained. To test the truth of this supposition I had a square pillar of Lemont limestone made by the Western Stone Co., 1 sq. ft. in cross-section, and about 9 ft. high. It was composed of seven stones, taken from their thickest stratum, and so cut as to lie on their natural bed in the pillar when this was set up. The bearing surfaces of the blocks were planed perfectly true. I sent this pillar to the government testing machine, at Watertown, Mass., and asked that it be set up by simply washing the beds with a very thin grout of the best English Portland cement. This pillar was subjected to the entire crushing power of the machine, 800,000 lbs., and it was only when the full strength of the machine was employed that the pillar showed the slightest symptom of yielding. Then small flakes were chipped off from the outside surfaces of two of the blocks, which is proof conclusive that the pillar was on the point of yielding. If pillars or columns having a cross-section of 4 sq. ft. instead of one were used, the total resistance of such pillar to crushing would be far more than four times 800,000 lbs., for it is a well known fact that the crushing resistance of any substance increases in greater ratio than the area of cross-section of such substance.

If, however, we assume that the strength was increased in that simple ratio, a pillar 2 ft. square, of Lemont limestone made as already described, would sustain a weight of 3,200,000 lbs. One-third of that load, or say, 1,000,000 lbs., would be a safe load for such a pillar. If we add a covering 2 ins. thick on all sides of a pillar, which is sufficient to afford it all necessary protection from fire, if a method is used which will shortly be described, the whole size of the pillar so protected would be but 2 ft. 4 ins. each way, which is but little larger than many of the steel columns now used with their fireproofing. These pillars would, of course, decrease in size as the loads decrease, story by story, from bottom to top of the building. The blocks of which they are composed may be doweled by a steel rod running down through the center of the pillar and connecting cap plates of cast iron that should be put on the pillars at the level of each story. These plates can project sufficiently to furnish a support to arches of tile, or beton Coignet, which should be used for the floor systems. The stones to be used for pillars and columns, as here recommended, should be such as to combine in the highest degree resistance to heat and strength to sustain loads. And they should be thoroughly protected by a covering at least 1 in. thick of that material which proves to be the best non-conductor of heat, and this should be covered either by a suitable hard finish or by tile. The sheet of agolite which I now show you is but one inch in thickness. It was exposed to a white heat applied on one side for half an hour; and it was then carried off on a man's hand, sustaining it on the reverse side without burning the hand. It consists of one part pulverized talc to three parts plaster of Paris. In wide buildings the pillars should be set in lines at right angles to each other, and at suitable distances to make it practicable to construct the whole floor by a groined arch or dome system supported by these pillars.

This system of floor construction is by no means new, as it has been in use for centuries in Spain and Italy. It has been recently introduced into this country by a Spanish engineer, Mr. Guastavino,* and has rapidly come into use in our Eastern cities. It has been found practicable to make strong floors with a very slight rise of the arch in proportion to the span. Steel rods have recently been built into the material of the floor thus constructed, so placed as to take and resist the horizontal thrust of the arches.

If the mode of construction here pointed out is adopted, the building would be practically unchangeable in its dimensions, indestructible by fire, abundantly strong and as durable as the materials of which it is composed. It also seems, from the best estimates I can make, that a building constructed in this way will cost less than one with steel and iron framing. Tile, brick and stone do not corrode, and, while mistakes may be made, and imperfections in design and workmanship are quite as likely to occur in the use of these materials as in that of iron and steel, these can be obviated in both cases by skill and fidelity, without which no system of building can be made successful.

Mr. W. L. B. Jenney, a warm friend and admirer of Gen. Sooy Smith, remarked in discussion of this paper:

"It seems to me the published account of this paper conveys a rather more sweeping criticism of the present building methods than he really meant. We all know there are some high buildings which are not sufficiently fireproofed; or, in general terms, are too cheaply constructed; but we also know that the high buildings put up by reputable builders, architects and engineers, are entirely free from criticism on that score. All good builders will fireproof sufficiently to guard against any heat possible from the materials to be stored in the building, or from the burning of surrounding structures.

There is almost no limit to the possibility of protection from heat by fire-clay. Take for instance the huge blast furnaces used by the great steel companies. They are constructed of iron and steel, protected from heat by fire-clay, and in spite of the temperature being 3,500° to 4,000°, and of the iron product ranging in them at a boiling heat day and night, these furnaces last four years before they have to be renewed. We fireproof according to the use to which the building is to be put. For instance, in the Fair and the Leiter Building much greater precaution is taken than if they were to be used as offices instead of for storing highly combustible merchandise. It is entirely possible to make a fireproof building which would stand the test of a fire from petroleum on every floor. The precaution that we take is enough, and there is no use in taking more, because it would be a useless expense.

Gen. Sooy Smith mentions the Minneapolis "Tribune" Building as an example of a fireproof, steel-frame building which went to pieces in a fire. That is not a fair example, as I have been informed by one of the tenants of that building at the time of the fire that the part that burned was never claimed to be fireproof, and that the part of the building that was fireproof did not burn.

As for the use of limestone pillars instead of steel, limestone behaves worse than steel when subjected to heat, and to make it serviceable it would have to be fireproofed as much as steel, and worse still, they would of necessity, be large and occupy valuable space. Limestone is friable, and at a comparatively low temperature turns to lime.

As to the deep piling with tops 15 ft. below datum, while it would doubtless be a good thing, it is unnecessary, in my estimation, and would only be a waste of money. The great high buildings put up on foundations supported by piers at datum are proving highly satisfactory. For instance, the Home Insurance Building has settled so uniformly that the greatest variation throughout is only ¾ in. The difficulty with Gen. Smith's proposed sub-basement would be that large pumps would have to be constantly worked to keep it dry. Chicago sewers are about 2 to 4 ft. above datum; and the large quantities of seepage into a basement 15 ft. below datum would entail a constant and heavy expense for pumping. In my opinion the objections to Gen. Smith's plan is that it is needlessly expensive. The present method of putting up buildings, if carefully and scientifically followed out, leaves nothing to be desired."

Mr. Dankmar Adler, of Adler & Sullivan, said:

"General Smith is right in saying that piling should be sunk so deep that the tops of the piles will be perpetually below the water line. In the German Opera House, which we are building, the tops of the piles are 6 ins. above datum. Unless the lake itself is lowered this will be deep enough for all time. The bottoms of these piles penetrate a very firm hard-pan which overlies the stratum of rock."

D. H. Perkins, Manager for D. H. Burnham, said:

"I do not like to criticise so great an authority as Gen. Sooy Smith at a moment's notice. I will say, however, that we favor the iron and steel construction and look upon it as the very best there is. All our buildings for 1892 will be built in that way. In my opinion an iron or steel column covered with fire clay will stand more heat than anything yet known. It will take more heat to penetrate this coating of fire-clay than will be generated by the combustion of any ordinary merchandise or furniture. As to the piling principle, we do not use it, and all our buildings stand on separate column footings which rest on the blue clay."

Shortly after the presentation of this paper (April 12, 1892), to a certain extent as a discussion thereof, Mr. Ossian Guthrie read a paper before the Chicago Academy of Science controverting Gen. Sooy Smith's conclusions and adducing some interesting geological and other facts in support of his views. The general nature of his paper, the substance of which is given below, is indicated by its title:

"The Nature and Value of Boring and Excavations in Geological Investigations and Their Relations to Chicago Foundations."

The borings heretofore made have been made with two distinct objects in view—one for the purpose of finding water, the other to ascertain the character and value of the material in relation to foundations. The first class of borings has yielded but little knowledge comparatively, either in aid of geological investigation or the study of the carrying capacity of the material underlying the city, for the reason that no system has been adopted for preserving the record. The second class of borings has only shown the individual making them the depth and character of the various strata through which he bored, and the public has only been benefited incidentally thereby. It is my belief that in many instances this class of borings, in relation to the clay, has been misleading in this, that as to the auger penetrated, more and more water accumulated at the bottom, and each succeeding section seemed softer than the last, and this has led to the conclusion that the clay is softer at the bottom than the top, which is not the case. Borings for either of the above mentioned purposes, properly recorded in the department of public works, would be of great public benefit. The state law provides, and the state geologist has made arrangements, for preserving all mining records for public reference, but Chicago as yet has made no provision for procuring and preserving this useful information.

The deep and extensive excavations of Chicago are co-extensive with her marvelous growth. It is from a knowledge gained by the improvement of these opportunities that I feel justified in saying that it is not a fact that the clay underlying Chicago is softer at the bottom and less capable of sustaining a load than at the top. These excavations are of great general value to the geologist. They reveal to him, not only the direction of glacial movement, but from the great variety of geological specimens found in making them, he can select and identify enough to almost enable him to determine the extent of the glacier which transported them hither. They also show the true character of the strata above the rock. The manner of deposition of the material of which they are composed clearly reveal the fact that the site of Chicago at the close of the last glacial epoch was an open bay, and formed a part of Lake Michigan, and later, that the drift sand from the lake shore at the north cut it off from the lake and formed an inland lake, which stood 11 ft. above datum. This lake in turn was silted up by the turbid flood waters of the Des Plaines River and the north branch of the Chicago River to the elevation upon which the pioneer built his cabin.

Geology of Chicago.

From a careful study of the geology of Chicago, with some experience in foundations and many years of (perhaps, well improved), opportunity, I have reached the conclusion that the foundation upon which Chicago rests is of remarkable uniformity, and ample for any load within the bounds of reason. In support of this conclusion I beg leave to call your attention to the following proofs:

In 1847 I assisted in laying the foundation for the old Bridgeport pumping works. This foundation was the first effort worthy of mention at foundation laying in Chicago, and antedated its successor by several years. This foundation was made of 12×12 oak timber, carefully imbedded on the clay, and covered with close jointed plank, and upon it the masonry was laid, and the ponderous machinery rested and operated for 23 years without showing a crack in the superstructure. For 20 years this foundation has supported the Danville elevator with equal success. Coming down to modern times, we find so much convincing proof that I only deem it necessary to call your attention to a few of the many modern structures of which Chicago may justly feel proud.

The Monadnock Building, which is built of solid masonry, is nearly 200 ft. high, fireproof, and one of the heaviest buildings in the United States, compared with the area covered by its foundation, upon every square foot of which there is a load of 3,750 lbs. This building has settled uniformly about 5 ins., where an allowance was made for 6, and not a single crack is visible in the entire structure. A dealer in building material said to me that the builder, during the process of erection, seemed to be striving to find places to add weight.

The foundation of the Western Bank Note Building was laid on the quicksand overlying the clay. This building, which is eight stories high, solid masonry, and fireproof, settled uniformly 2½ ins.

The Home Insurance Building only settled ¾ in., with the addition of two stories. The new Fair Building, ten stories high, combination of steel and masonry, with all its load, only settled 1 in.

In a recent article, evidently published for the purpose of showing the weakness of Chicago foundations and the necessity for going down to rock, reference was made to the Post Office and Owings Building, neither of which can be considered as fair criterions by which to judge. In relation to the Post Office, everybody who knows anything about foundations, and who saw that foundation in process of construction, knows that it was not suitable for a substantial six-story office or commercial building.

It is a matter of surprise to me that the Owings Building should have been referred to in a paper designed to show the weakness of Chicago foundations, for the following reasons: A combination foundation of concrete and steel was laid, and upon this dimension stone walls and piers occupying almost the entire basement story were constructed, and upon these walls and piers a fireproof building of solid masonry was erected 13 stories high, exclusive of the gable roof and the story devoted to foundation, and yet this building has settled so little as to be imperceptible to a careful observer, and the adjoining 9-story building, also of solid masonry, has suffered but little from the settling of its massive neighbor.

* See Engineering News, Nov. 9, 1889.

In so far as the publications referred to tend to discourage the erection of other "sky scrapers," they are all right, but if the object is to furnish a pretext for going to the rock for the foundations of the future structures of Chicago, or effect a substitution of limestone piers for steel or iron columns, in my opinion they are not only needless, but reprehensible.

I repeat, the clay underlying Chicago is wonderfully uniform in carrying capacity, and ample for any future structure erected, with a proper regard for the interests of the public.

THE PRICE RAIL JOINTS.

The endeavor to devise a rail joint which shall be an improvement upon the forms of joint now generally used is occupying the time of many inventors, and various forms of joints in actual use have been illustrated in our columns. We illustrate this week three forms of joint which are the invention of Mr. James M. Price, of Philadelphia, and 200 of which are to be given a trial on the Philadelphia & Reading R. R. On the same road 200 metal ties of Mr. Price's invention are to be laid this autumn, near Philadelphia, and we expect to publish details of these ties later. The joints and ties are being placed upon the market by the Price Railway Appliance Co., 125 South Fifth St., Philadelphia, Pa.

Each of the joints is designed upon the "bridge" principle, supporting the base of the rail across the space between the two joint ties, upon which the ends of the bridge rest. In each case, also, it will be noted that the rail is not supported across the whole width of its base, each side of the base fitting into a groove in one of the two combined bridge and splice plates. The joints are made of malleable iron or cast steel, and will weigh about 30 to 40 lbs. per pair for the present average spacing of ties. In the design of the joints Mr. Price has sought to place the metal to greatest advantage to secure a casting with maximum strength for the given weight and quantity of material. It has also been his purpose to discard the slanting support given by the top of the ordinary splice bar to the inclined surface of the underside of the rail head. He claims, in view of the constantly recurring fractures of splice bars and the consequent danger to life and traffic, that if the base of the rail is held by an absolutely tight joint and is also adequately supported from below, the knocking and jar at the rail joints may be overcome, and in all of his joints he has aimed to secure a downward pressure upon the base. No cutting of the ties is required, but if it is desired to use these joints in connection with tie plates on other ties, the rail seat may be made the full length of the joint and of the same thickness as the tie plates. The vertical part of each plate projects over the ties, and presses against the web of the rail at its inner edge.

The "Double Girder" joint, Fig. 1, consists of two plates, with the ends resting on the ties, each plate having a grooved recess to engage with the edges of the base and give a "bridge" support, and having contact with the head of the rail for only about 3 ins. at the middle of the joint. The plates are strengthened on the inside and outside by two circular or elliptical arches or ribs, placed foot to foot, with the inverted arch so shallow as to disturb the ballast but little if at all. The outer arched ribs are connected by radial ribs, which embrace the part forming the rail seat. The greater the weight of wheel load the heavier is the load on the lip or jaw bearing on the top of the base. A pair of malleable iron plates weighing 44 lbs. without bolts were attached to two pieces of 85-lb. rails of the Pennsylvania R. R. standard section, 18 ins. long, and placed on supports 15 ins. apart, and this joint when tested in a Riehle testing machine, showed the deflection and set in thousandths of an inch as given in the accompanying table. It is thought that ample strength can be secured with a weight of 36 lbs. per pair. Four splice bolts are used.

Test of Price "Double Girder" Rail Joint.

Load, lbs.	Defl., ins.	Set, ins.	Load. lbs.	Defl., ins.	Set, ins.
10,000	.019	.000	50,000	.054	.013
20,000	.029	.005	60,000	.067	.020
30,000	.038	.008	80,000	.091	.040
40,000	.044	.009	100,000	.120	.065

The "Spoke" joint, Fig. 2, is very similar, but the top of the vertical plate has a horizontal rib reaching to and touching the top of the web of the rail and supported at each end by an extension of this rib to the base of the plates. Strengthening ribs are used as in the "Double Girder" joint, and the lower arch is of greater width. Four splice bolts are used.

The "Ribbed Truss" joint, Fig. 3, avoids the use of splice bolts through the rail, the four bolts passing through the lower parts of the joint plates, below the rail. Each plate of this joint has a horizontal base, deeply scalloped to reduce the weight and to permit a greater strain on the bolts. From this base rises the vertical web carrying the jaws which hold the edge of the base of the rail, and the web and jaws are reinforced by heavy ribs.

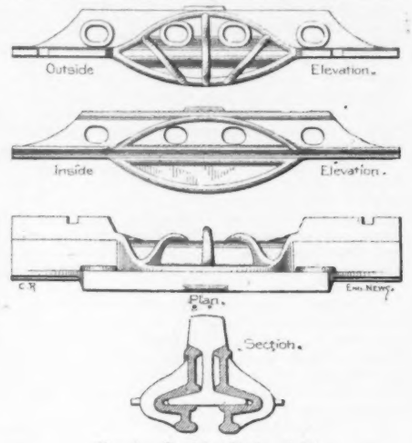


Fig. 1. Double Girder Joint.

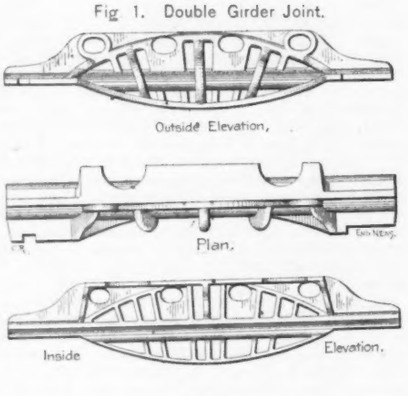


Fig. 2. Spoke Joint.

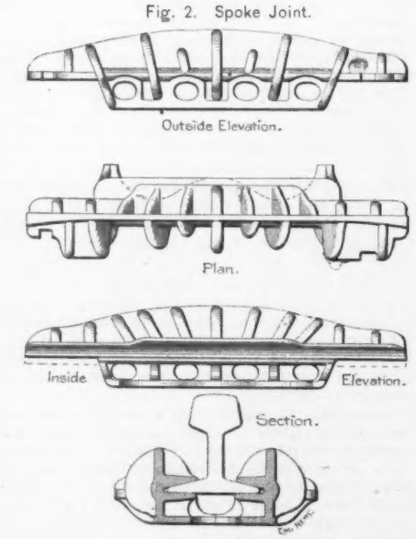


Fig. 3. Ribbed Truss Joint.

In view of the increasingly heavy loads sustained by rail joints, and the amount of labor required to maintain them, there should certainly be a good field for an efficient and economical joint, which must be of as simple construction as possible, and for this purpose the "bridge" principle appears to offer many advantages.

PERSONALS.

Mr. Ernest E. Cook has been appointed City Engineer of Council Bluffs, Ia.

Mr. John T. McBride has been appointed superintendent of the Chicago terminals of the Illinois Central R. R.

Mr. E. H. Keating, City Engineer of Toronto, Ont., Canada, has appointed Mr. C. H. Rust as Deputy City Engineer, at a salary of $2,500. Mr. Rust was formerly Assistant Engineer in Charge of Sewers.

Mr. J. D. Hawks, Chief Engineer of the Michigan Central R. R., has resigned his position to accept that of Manager of the Detroit Citizens' Street Ry. Mr. A. Torrey has been appointed Acting Chief Engineer.

Mr. Alexander Potter, civil and sanitary engineer of Olean, N. Y., sails on Dec. 8 to generally examine and report upon sewage disposal works in Europe. He has been especially engaged by the owners of tanneries in North Olean to report upon processes for disposing of the waste liquids from their works, now shut down by an injunction from the owners of the stream below for contaminating the water supply.

Hon. B. F. Chadbourne, of Biddeford, Me., has been appointed Railroad Commissioner of Maine, vice Mr. R. L. Bowers, deceased. Mr. Chadbourne was connected with the engineer staff of the Portland & Ogdensburg R. R. in 1869, and later was connected with the Eastern R. R. and the Pennsylvania R. R. In 1873 he returned to Maine and studied law, later entering practice. From 1881 to 1885 he was engaged in railway work in the South, and then went into the practice of law at Biddeford, Me.

Col. Richard J. Hinton, M. Am. Soc. Irrigation Engrs., who had a part in conducting the irrigation and underflow investigations for the U. S. Department of Agriculture, has opened an office as Consulting Irrigation Expert at 1215 L St., Washington, D. C. Col. Hinton is the author of valuable government reports on irrigation, was an engineer of the U. S. Geological Survey in 1889-1890, and was expert engineer for the U. S. Senate committee on irrigation. He will investigate and report upon projects in behalf of bankers and investors, to many of whom he is already well known, and will undertake confidential investigations. He is thoroughly familiar with the arid region.

NEW PUBLICATIONS.

THE PAVING PROBLEM.—Importance, methods, materials, health. A Paper by Jas. W. Howard, C. E., Read Before the Board of Trade, Scranton, Pa. Pamph.; pp. 22.

This paper presents some interesting facts and correct principles regarding street paving in a manner designed to convince business men that good pavements are economical, even if their first cost is comparatively high.

ELECTRIC RAILWAYS.—Recent progress in. Being a summary of current periodical literature relating to Electric Railway Construction, Operation, Systems, Machinery, Appliances, etc. Compiled by Carl Hering, New York.—The W. J. Johnston Co., Ltd.; 12mo.; cloth; pp. 386. 120 illustrations, $1.00.

This is probably the most generally useful and interesting work yet published on this important subject. In a comparatively new enterprise, one that is constantly expanding and improving, the history of this progress must be looked for in the technical journals. But, on the other hand, this journalistic record is so scattered in its figures and details that it is practically accessible only to the expert who is constantly on the watch for interesting or important items. Mr. Hering is such an expert, and he has done a good and acceptable work in the book before us. The title sufficiently outlines the scope of the book, and we can only add that the author has done his work conscientiously and well.

A TEXT-BOOK ON THE METHOD OF LEAST SQUARES.—By Mansfield Merriman, Prof. C. E., Lehigh University, etc. 6th edition. New York, John Wiley & Sons; 8vo; pp. 198; 12 cuts; 6 tables. $2.

This is merely a new edition, somewhat revised and extended, of a treatise of which we have before spoken highly, but we regret to see that the revised edition still has two serious defects in it, to which we have before called attention, and which we are surprised to see are still uncorrected. The first is that the algebraic symbols, once introduced, are thereafter used freely throughout the volume, with few or no attempts to define what they mean, so that there is hardly a formula in it the symbols in which are explained anywhere in connection with it. One must hunt through the volume in a dozen places to find out what the different letters in it mean. This offense is aggra-

vated by the fact that very often a single letter means (besides something which might be easily explained in words) a whole formula given somewhere else, which, in its turn, contains a batch of fresh symbols, the meaning of each of which must be hunted for still further back in the same way.

The second defect is like unto this, and even less excusable. By the tables at the end of the volume the method of least squares may be used understandingly, like a table of logarithms, with very little knowledge of how the tables are computed, or of the precise theory on which the method rests. The busy man who has occasion to use it, and buys a text-book on it to that end, has a right to expect that the method of using it will be made as plain and simple as possible for those who wish it simple, however elaborately explained for those studying its theory. Yet the tables which would otherwise enable him to do so are headed only with terrific-looking formulas and letters, and the alleged "Description of the Tables," which appears on a preceding page (but is not referred in connection with the tables themselves), is no description at all, since it deals only with letters, the meaning of which can be found only by the laborious and uncertain process stated.

It would almost seem as if the author had been consciously willing to make the book hard to use for the sake of "mental discipline" which his students would thus gain. But mental discipline of this kind is mere vexation. Besides the loss of time, it induces, as Mark Twain remarked, "barrels and barrels of profanity, which might all be saved, and devoted to some other end, where it would do more real and lasting good."

TABLE BOOK for Civil and Mechanical Engineers. Compiled by George W. Plympton, M. Am. Soc. C. E. Van Nostrand Science Series. No. 104; 18mo; cloth; pp. 195. 50 cents.

AN INTRODUCTION to the Study of Determinants, with Examples and Applications. By G. A. Miller, A. M., Ph. D., Professor of Mathematics, Eureka College. Van Nostrand Science Series. No. 105.; 18mo, cloth; pp. 110. 50 cents.

TRADE PUBLICATIONS.

CATALOGUE OF THE UNION IRON AND FOUNDRY CO., OF ST. LOUIS. 4to, pp. 63. Illustrations.

This catalogue is worthy of note for its many excellent designs for iron store fronts, columns and railings. These designs are not only artistic, but they have the added merit of showing that they are really made of cast or wrought iron, and are not imitations of other materials.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Oct. 5, Mr. Ockerson exhibited a series of blue prints showing the changes in the Mississippi River channel for the last twelve years. Mr. Melcher exhibited a number of blue prints and photographs of the Lidgerwood machinery. At the next meeting, Oct. 19, a paper on "Steam Engine Efficiency, Its Possibilities and Limitations," by Mr. W. H. Bryan, will be presented.

AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS.—The 21st annual meeting was held at the Hotel Brunswick, New York City, on Oct. 10. The following delegates were present from other railway technical associations. Master Mechanics', J. N Lander, John Mackenzie; Master Car Builders', E. J. Grieves, J. N. Barr, R. C. Blackall; Roadmasters', John Doyle. W. H. Stearns; Train Dispatchers', I. H. McEwen, W. H. Groves.

The following officers were elected: President, H. Stanley Goodwin; Vice-Presidents, Geo. W. Beach, C. H. Platt; Treasurer, R. M. Sully; Secretary, C. A. Hammond. All re-elections, excepting the Vice-Presidents. Mr. Beach succeeds Mr. C. W. Bradley, of the West Shore, and Mr. Platt takes the place Mr. Beach held last year.

WESTERN RAILWAY CLUB.—At the meeting on Sept. 20, Mr. E. M. Herr's paper on "Irregular Wear of Locomotive Driving Wheel Tires" was discussed by Messrs. W. H. Lewis and Wm. Forsyth. The important points developed in the discussion were that correct balancing is not very important in its effect on tire wear, and even when an engine is very badly balanced the effect on the wear is inconsiderable. It was also shown that there may be such a thing as imperceptible slip at high speeds, especially with engines having heavy counterbalances. The centrifugal force of the counterbalance may reduce the pressure on the rail at very high speeds faster than the mean effective pressure in the cylinder is reduced.

A paper on "Steam Car Heating" (published in our issue of Sept. 29) was read by Mr. A. M. Waitt, after which the election of officers was held, resulting as follows: President, W. H. Lewis; Vice-President, A. M. Waitt, Wm. Forsyth; Secretary, W. H. Marshall; Treasurer, Allen Cooke. The October meeting will be omitted, and instead the club will visit the World's Fair Grounds in a body on Oct. 25. A special train will be furnished by the Illinois Central R. R. for the use of the Club.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Oct. 5, President Mendes Cohen in the chair, two papers were read by the Secretary, as noted in our last issue. The first was on "Combination Bridge Building on the Pacific Coast," by Mr. Alfred D. Ottewell. It was a short paper, and there was but little discussion; Mr. Cohen giving some particulars of the early combination bridges on the Baltimore & Ohio R. R., and Mr. Geo. H. Thomson describing some curiosities in bridge construction. The second paper was on "Some Notes on Foundation Experiences," by M. A. P. Boller, an abstract of which was published in our issue of July 28, the paper having been presented at the annual convention. Mr. Brendlinger described a case in which a timber crib 14 ft. deep for the foundation of a bridge pier, was sunk in place by means of loading the pockets with stone, and almost immediately rose to the surface, the two bottom courses with the flooring, having dropped off. While afloat, the crib was tilted over, and one side covered with three layers of plank spiked on, the crib then tilted over the other way and the other side planked. A heavy floor ing or decking was then built over the open top, and the crib then loaded so as to tip it bottom side up, the decking then forming the bottom. The stone and timber from the crib, as originally used, were then dredged away, and the crib successfully sunk.

The following candidates were declared elected:

Members: Charles Lee Crandall, Assoc. Prof. of Civil Engineering, Ithaca, N. Y.; William L. Darling, Prin. Asst. Eng., Northern Pacific R. R., Helena, Mont.; A. J. Du Bois, Prof. of Civil Engineering at Yale University, New Haven, Conn.; Ignacio Gallis, Chief Inspector, National Ry. of Tehuantepec, City of Mexico, Mexico; Wallace C. Johnson, Engr., Niagara Falls & Suspension Bridge Ry. Co., Niagara Falls, N. Y.; Harvey Linton, Cy. Engr., Altoona, Pa.; Lewis A. Nichols, Chf. Engr., La Salle & Bureau County Ry., La Salle, Ill.; Joseph H. Paddock, Chf. Engr., H. C. Frick Coke Co., Connellsville, Pa.; Charles H. Wright, Engr. of Details and Drafting, Edge Moor Bridge Co., Wilmington, Del.

Associate Members: Robert G. Gemmell, Engr., Pendleton, Ore.; Francis A. Lyte, Cy. Engr., Kane, Pa.; Sidney A. Parsons, First Asst. Engr., Everett Land Co., Everett, Wash.; Geo. H. Sherwood, Riverside, Cal.; Jonas W. Smith, Asst. Engr., East Jersey Water Co., Montclair, N. J.; William deH. Washington, Gen. Man., Hydraulic Construction Co., New York, N. Y.

The nominating committee appointed at the last annual convention having presented to the Board of Direction nominations for officers for the ensuing year, the Board has, as required by the constitution, taken action upon the same, and has ordered the following nominations to be sent out for the information of the corporate members. The treasurer, secretary and treasurer are to serve one year; the vice-presidents, two years, and the directors, three years.

For President: William Metcalf, Pittsburg, Pa.

For Vice-Presidents: Charles Macdonald, New York, N. Y.; Elmer L. Corthell, Chicago, Ill.

For Directors: Foster Crowell, New York, N. Y.; Henry G. Prout, New York, N. Y.; Willard S. Pope, Detroit, Mich.; Frederic P. Stearns, Boston, Mass.; John T. Fanning, Minneapolis, Minn.; Olin H. Landreth, Nashville, Tenn.

For Secretary: Francis Collingwood, New York, N. Y.

For Treasurer: John Bogart, New York, N. Y.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The regular monthly meeting was held at Pittsburg, Pa., Sept. 20, Mr. Alfred E. Hunt, President, in the chair; Mr. R. N. Clark, Secretary; 50 members were present.

Mr. Gustave Kaufman read the paper for the evening, on "The Reconstruction of the Ninth St. Bridge, Pittsburg." This bridge, finished in 1840, was originally of the Burr type of combined arches and trusses, and consisted of one span of 190 ft., and four spans of 200 ft., in the clear of masonry. The piers were 9 ft. wide on top and 35 ft. long; they had semi-circular ends, thus making the total length of the piers 44 ft. The foundations of all masonry in the river were timber platforms. The price paid for the masonry was about $7 per cu. yd. The substructure cost about $37,000, and the superstructure about $33,000. With approaches, the bridge cost about $80,000. The bridge was covered on all sides and top, and offered great resistance to the wind. In 1889 this bridge, which was still in a safe condition for slow traffic, fell into the control of the Pleasant Valley Electric Street Ry. Co., who at once began to replace the old structure with one that would be adapted to rapid transit traffic purposes. The requirements of the company were as follows: 1, The new structure to be wide enough for four lines; two for quick, rapid transit and two for slow transit; and two for sidewalks of 10 ft. each; 2, The old masonry to be used; 3, The old structure to be removed, and traffic maintained during the erection of the new bridge; 4, The structure to be designed on strictly economical principles; no ornaments to be used; the superstructure to consist of five spans of plain Pratt trusses.

The load on the floor to be twelve tons on two pairs of wheels 10 ft. apart, or a uniform load of 100 lbs. per sq. ft. The trusses to be figured to carry a moving load of 4,000 lbs. per lin. ft. The work necessitated the building of a new abutment on the Pittsburg side, the rebuilding of the tops of all the piers, a new pier on the Allegheny side, and an entirely new superstructure, the trusses of which are steel, and the entire floor and lateral system of iron. The paper described in detail the work as performed, including the strengthening of the masonry on the piers by the inflow of hydraulic cement, the cutting down and rebuilding the tops of the piers, the removing of the skewbacks and the building up of the piers to a uniform section between the new trusses, and the raising of the bridge spans to meet the requirements of the U. S. Engineers. The work was completed in the fall of 1890, without injury to any person, and practically without cessation of traffic.

In the discussion reference was made to the old tubular bridge at Brownsville, Pa., which was built in 1822, and is believed to be the first tubular bridge built in the United States.

At the meeting of the Chemical Section, on Sept. 27, Dr. Chas. B. Dudley, Chemist of the Pennsylvania R. R. Co., delivered an address on "Causes of Discrepancy in Chemical Analysis." He thought there were four possible causes: 1, Non-uniformity of samples; this trouble could be discovered by exchange of samples; 2, Impure chemicals; chemists in cases of dispute should exchange both samples and chemicals; 3, Poor manipulation; this can generally be discovered if the two chemists work together; 4, Faulty or varying methods; the adoption of uniform methods would be very desirable. He quoted from a well known professor, who used to say: "No chemist has ever made an accurate analysis. Some chemists can work close enough to accuracy so that their work is valuable."

COMING TECHNICAL MEETINGS.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Oct. 15. Secy., F. D. Jones, Helena.

ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 15. 1122 Girard St. Secy., L. F. Rondinella.

AMERICAN ASSOCIATION OF SUPERINTENDENTS OF RAILWAY BRIDGES AND BUILDINGS.
Oct. 18. Annual convention. Palace Hotel, Cincinnati, O.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Oct. 19. Secy., S. E. Tinkham, City Hall.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Oct. 19. Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
Oct. 19. Secy., Arthur Thacher, Odd Fellows' Building.

AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richardson, Brooklyn, N. Y.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Oct. 20. Secy., C. F. Franson, 113 Adams St.

NEW YORK RAILROAD CLUB.
Oct. 20. Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
Oct. 20. Secy., J. F. Wilson, 24 W. 4th St.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Oct. 21. 201 Washington Building.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22. Roanoke, Va. Secy., J. R. Schick, Roanoke.

WESTERN SOCIETY OF ENGINEERS.
Nov. 2. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
Nov. 3. Secy., F. W. Cappelen, 1628 Hennepin Ave.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Nov. 3. Secy., C. H. McLeod, Montreal, P. Q.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Nov. 4. Secy., E. K. Smoot, 803 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Nov. 4. Secy., O. Von Geldern, 719 Market St., San Francisco.

SWEDISH ENGINEERS' CLUB.
Nov. 5. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
Nov. 5. Union Station, St. Paul.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Nov. 7. Secy., C. L. Annan, City Engrs. office.

NORTHWESTERN SOCIETY OF ENGINEERS.
Nov. 8. Secy., F. H. Warner, Seattle, Wash.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Nov. 8. Secy., Chas. S. Howe, Case School.

DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Nov. 8. Secy., Geo. H. Angell, 36 Jacobson Block.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
Nov. 8. Secy., Parker N. Black, Capitol Block.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Nov. 9. Wichita, Kan.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Nov. 10. Secy., Edward Mead, Norton Building.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Nov. 10. Secy., E. N. Clark, Pittsburg, Pa.

WESTERN RAILWAY CLUB.
Nov. 10. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERING ASSOCIATION OF THE SOUTH.
Nov. 10. Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Nov. 11. Secy., D. W. Meeker, St. Paul.

WISCONSIN POLYTECHNIC SOCIETY.
Nov. 14. Secy., M. G. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
Nov. 14. Secy., Waterman Stone, Baird Building.

NEW ENGLAND RAILROAD CLUB.
Nov. 14. Secy., F. M. Curtis, O. C. R. R., Boston.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Nov. 14 to 18. Annual meeting. Secy., F. R. Hutton, 12 West 31st St., New York.

ROADMASTERS' ASSOCIATION OF AMERICA.
Nov. 15, 16, 17. Chattanooga, Tenn., and Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Charpiot, Macon.

CENTRAL RAILWAY CLUB.
Nov. 23. Secy., S. W. Spear, E. Buffalo, N. Y., Iron Works.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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The cholera excitement has done a good work for Providence, R. I., in inducing the councils of that city to appropriate $1,500,000 and to order under immediate construction the sewage disposal system of that city. Over eight years ago, in 1884, Mr. Samuel M. Gray, then City Engineer, personally studied abroad all the chief disposal plants and drew up complete plans for a disposal system adapted to Providence. This plan was fully approved of by a commission of the ablest engineers in this country and the City Councils finally adopted this plan in its entirety and ordered the Commissioner of Public Works to begin construction. This work in general terms included the leading of all sewage to a common point, remote from the city, and its chemical treatment before discharging at Field's Point into the waters of Narragansett Bay. If this disposal system was badly needed eight years ago the work done since in sewer construction has added much to this need, and the citizens should thank the present excitement for putting an end to local complications that have so long delayed a work of imperative public necessity. In the meantime Mr. Gray is to be congratulated on this somewhat tardy recognition of the good work he has done for the people of Providence in solving a very knotty problem. That it is the best that could be done is very well proved by the fact that no better plan has been presented in the long interval that has elapsed since 1884.

The recent shipwreck on Lake Superior in which the steel steamer "Western Reserve" is claimed to have broken in two has called general attention to the possible structural weakness of very long vessels with the small depth of hull made necessary by the limited draft in the lake canals. The ill fated steamer was a fair type of the steel propellers on the Great Lakes which have been built during the past four years, except that she was probably better built than the average. Her dimensions were: Length over all, 300 ft.; beam, 41 ft.; depth, 25 ft. In the attempt to secure the greatest cargo capacity with the least weight of vessel and smallest expense in construction, a type of vessel has been evolved on the Lakes quite different from anything known on the ocean. The boilers and engines are crowded back as near the stern as possible, leaving the space amidships entirely free for the bulk cargo of grain, coal or ore. The vessel is practically a steel shell, and when poised on the summit of a wave amidships is subjected to bending stresses from the weight of the ends of the vessel and of the machinery in the stern. The strength of the vessel to resist this strain depends on the thickness of the plates in her sides, the size of the ribs, which correspond to the stiffeners on a plate girder, and the strength and frequency of the transverse bulkheads, which brace the sides and prevent them from warping and buckling when under strain. Whether the present lake vessels are built with thinner plates, lighter ribs or less bulkhead bracing than safety demands is a question which will be more carefully considered by builders and owners since the weakness of one vessel has caused disaster. Already a movement for the establishment of a set of rules for the proportioning of vessels has been started, and a meeting to discuss the project was held at Detroit on Sept. 20. The marine underwriters who do business on the lakes are strongly in favor of the plan, and their influence with shipowners and builders is very great. There is already a set of rules in extensive use on the Atlantic coast established by the American Shipmasters' Association, of which Mr. E. Platt Stratton, M. Am. Soc. M. E., is Chief Engineer. Lake owners and builders, however, have thus far built as they pleased; and they are naturally averse to anything which will increase the cost of construction or will hamper them in their efforts to reduce deadweight and increase carrying capacity. But such disasters as the loss of the "Western Reserve" and the increase in rates of insurance which is likely to follow may convince them that greater regard for safety will pay in the long run.

RAILWAY CONSTRUCTION IN THE SOUTHWEST.

The statistics of railway construction in the Southwestern states, which we present in this issue show a large increase over last year's figures in the mileage of track laid to date, but a very heavy decrease in the mileage of new road in process of construction, and under survey and projected. According to the figures as collected, 2,562 miles of work of all classes are under way compared with 8,073 miles in progress one year ago, a decrease of 68.1%. This indicates a greater decrease in activity than has been shown by any other section of the country, as will be seen upon examination of the previous maps of this year's series. (Eng. News, March 5, April 9, and June 23 and Aug. 4, 1892). The figures indicate a greater depression in active work than is really the case, however, as will be explained further on. In the following table is shown the mileage of new work of the various classes in progress in each state:

State.	Track laid. In year 1891.	Track laid. To date in 1892.	In process of construction.	Located and under survey.	Projects of some promise.
Mo.	30	57	184	248	39
Kan.	2	...	...	18	...
Ind. Ter.	11	116	...	89	...
Ark.	82	11	144	158	312
La.	151	55	62	72	125
Tex.	135	103	198	477	194
Total.	511	342	588	1,062	570

Texas takes the lead in the mileage of new road with 972 miles under way, and is followed by Arkansas and Missouri with 625 miles and 508 miles respectively. The total work under way in the six states compared with similar figures for 1891 gives the following results at the dates named:

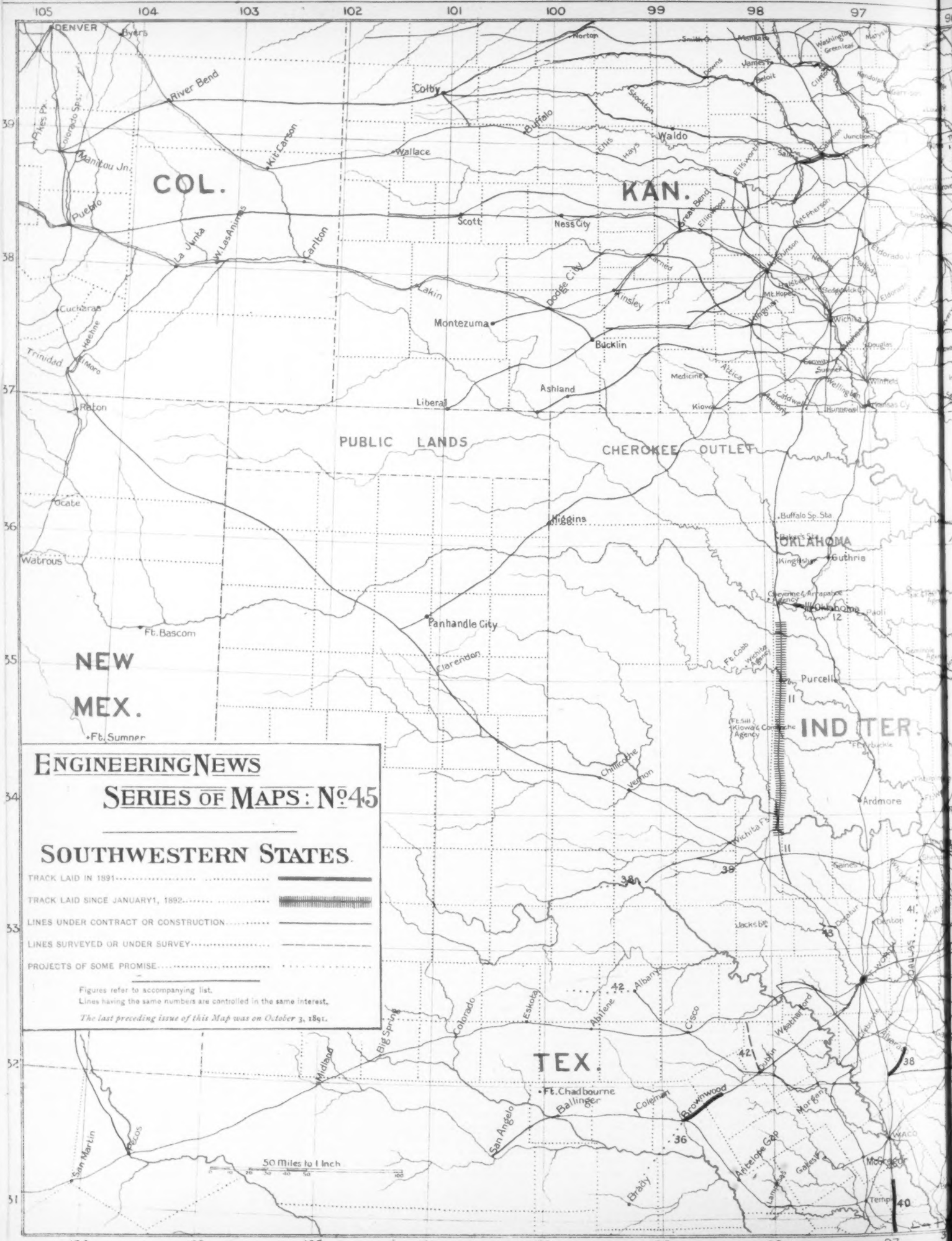
	Track laid Year previous	Track laid Portion of year to date.	Under construction.	Under survey.	Projected.
Oct. 3, 1891.	841	217	1,011	2,638	4,207
Oct. 13, 1892.	511	342	588	1,062	570
Inc. or Dec., 1891.	-330	+125	-423	-1,576	-3,737
" " P. C.	-39.2	+57.7	-41.8	-59.8	-88.9

Those who have studied our previous maps this year are familiar with the effects of the industrial depression of 1891 upon the current railway construction throughout the country. It would seem, however, from the above figures that the effects of this depression were especially severe upon the railways in the section of the country now under consideration. This is undoubtedly largely true, and, as in the Southern states which exhibit the next greatest decrease in new construction, the reason is not difficult to find. The larger railways of the Southwest which did so much construction in 1887 and 1888 had, with one important exception, practically given up any active work on further extensions previous to the fall of 1890. This left only the various enterprises of a local character and consequent financial weakness and the several more or less doubtful projects of the old companies, together with the usual quota of active enterprises which were carried to completion as shown in our records of track laid during each year. A large proportion of the lines shown as projected and under survey on our maps of 1889, 1890 and 1891 were such relics of the "boom" times, and their only excuse for existence was that some sparks of life seemed to remain in them which under a favorable industrial breeze might be fanned into flame. The actual conditions were unfavorable, and during the industrial calm following the financial disturbances of the fall of 1890 most of these enterprises died out entirely or were weakened beyond any further possibility of activity for some time. As the general depression in railway work discouraged the inception of new enterprises, there were almost no new lines to take their places. The result is to show an apparently abnormal decrease in the prospects for future activity of railway work as exhibited by the figures. This, however, is not entirely true. There has, of course, been a decrease in the amount of work projected for the near future, but this decrease is not more than was to be expected from the unfavorable conditions, if we eliminate the very considerable mileage of practically defunct lines before mentioned.

It will be seen that the figures of actual construction of new railway up to date this year, when compared with similar figures for 1891, give a result directly opposite in character to those obtained by comparing the figures of mileage in the various other stages of progress. Nearly 58% more track has been laid in this section to date in 1892 than was laid in the same period of 1891. This, however, does not indicate more general activity in the current construction, for nearly all of this track has been laid by a few of the older companies on extensions long under way, while very little has been done by the smaller independent companies. Judging from the work now under way, the remainder of the tracklaying for this year will probably show a much larger proportionate part laid by the smaller companies than for the nine months passed. Taking the Southwestern states as a whole, the work now in sight indicates that nearly if not quite as much track will be laid this year as there was last.

Among the larger companies having the largest amount of active work in progress, are the Chicago, Rock Island & Pacific Ry. Co., the Missouri, Kansas & Texas Ry. Co., and the Texas Central Ry. Co. The Missouri Pacific Ry. Co., which has done considerable work during the past two years, is now doing but little in the way of new construction. By far the largest stretch of track laid this season is the extension of the Chicago, Rock Island & Pacific Ry. south from Minco, I. T., through Indian Territory and Texas. This line is 128 miles long, as far as now graded, to Bowie, Tex., and 104 miles of track have been laid. The Missouri, Kansas & Texas Ry. has resumed work on several long delayed extensions in Texas, the location of which is given in the detailed list. The company's most important extension, however, is the Missouri, Kansas & Eastern Ry. from Franklin, or Boonville, Mo., east along the north bank of the Missouri River to a point about twelve miles east of St. Charles, Mo., where connection will be made with the branch of the Chicago, Burlington & Quincy R. R., now under construction, into St. Louis. The object of this line is to give the company a through line from St. Louis, Mo., to Houston, Tex., and its construction together with the lines in Texas is in accordance with the policy of the reorganized company to round out and make compact the former disjointed system. Nothing further than some surveying has been done on the three projected branches of the Texas Central Ry., but there is a probability of construction being commenced, possibly soon. Their location is given on the map. It will be seen from the foregoing that most of the older companies are yet holding aloof from much new construction.

Turning now to the smaller companies and the various new and independent projects we find a general dearth of lines of other than merely local importance. As before stated the more ambitious schemes have been wiped out by the unfavorable conditions, and but few new ones have been organized to take their places. Among the older of these independent companies are the Kan-



ENGINEERING NEWS
SERIES OF MAPS: No. 45

SOUTHWESTERN STATES.

TRACK LAID IN 1891.....

TRACK LAID SINCE JANUARY 1, 1892.....

LINES UNDER CONTRACT OR CONSTRUCTION.....

LINES SURVEYED OR UNDER SURVEY.....

PROJECTS OF SOME PROMISE.....

Figures refer to accompanying list.
Lines having the same numbers are controlled in the same interest.

The last preceding issue of this Map was on October 3, 1891.

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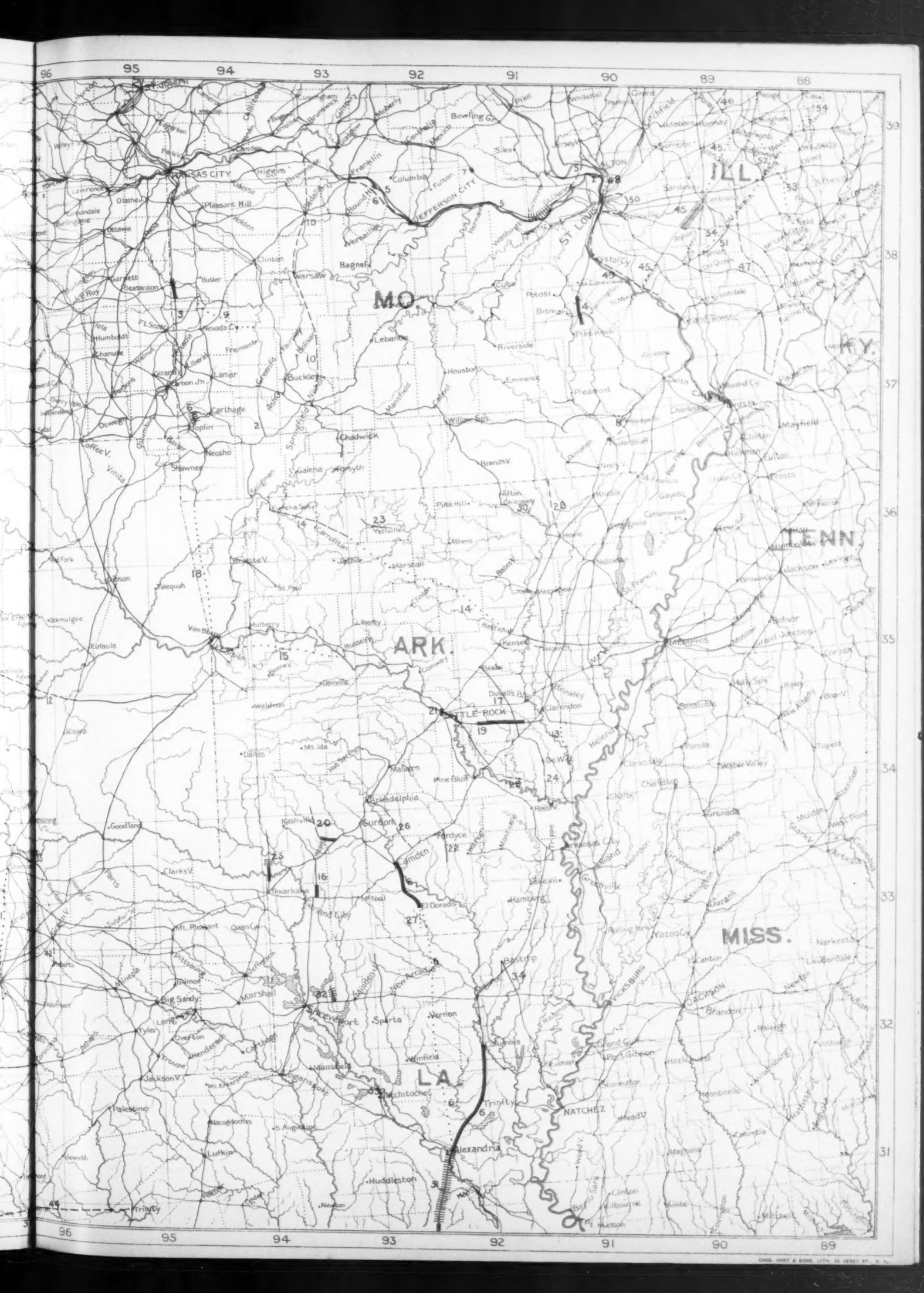

MO.
ARK.
LA.
MISS.
ILL.
KY.
TENN.
KANSAS CITY
ST LOUIS
JEFFERSON CITY
LITTLE ROCK
MEMPHIS
NATCHEZ
VICKSBURG
JACKSON
ALTON
Joplin
Springfield
Fayetteville
Fort Smith
Texarkana
Shreveport
Monroe
Alexandria
Natchitoches
Trinity
Camden
El Dorado
Pine Bluff
Helena
Greenville
Clarksdale
Greenwood
Grenada
Tupelo
Columbus
Meridian
Hattiesburg
Laurel
Baton Rouge
Lake Charles
Beaumont
Houston
Galveston
Corpus Christi
San Antonio
Austin
Waco
Dallas
Fort Worth
Wichita Falls
Abilene
Sweetwater
Big Spring
Midland
Odessa
Pecos
El Paso
Amarillo
Lubbock
Plainview
Childress
Vernon
Wichita
Hutchinson
Salina
Topeka
Lawrence
Kansas City
St Joseph
Omaha
Lincoln
Grand Island
Hastings
Kearney
North Platte
Cheyenne
Denver
Colorado Springs
Pueblo
Trinidad
Raton
Santa Fe
Albuquerque
Gallup
Flagstaff
Phoenix
Tucson
Yuma
San Diego
Los Angeles
San Bernardino
Bakersfield
Fresno
San Jose
San Francisco
Oakland
Sacramento
Stockton
Reno
Carson City
Las Vegas
Salt Lake City
Ogden
Provo
Cheyenne
Rock Springs
Green River
Evanston
Pocatello
Boise
Twin Falls
Portland
Salem
Eugene
Medford
Klamath Falls
Seattle
Tacoma
Everett
Bellingham
Spokane
Walla Walla
Yakima
Wenatchee
Olympia
Aberdeen
Hoquiam
Astoria
Longview
Vancouver
Kelso
Centralia
Chehalis
Raymond
South Bend
Willapa
Long Beach
Ocean Park
Ilwaco
Cape Disappointment
Grays Harbor
Willapa Bay
Columbia River
Puget Sound
Strait of Juan de Fuca
Pacific Ocean
Gulf of Mexico
Mississippi River
Missouri River
Arkansas River
Red River
Ohio River
Tennessee River
Cumberland River
Lake Michigan
Lake Superior
Lake Erie
Lake Ontario
Lake Huron

sas City, Ft. Smith & Southern Ry. and the Kansas City, Arkansas & New Orleans Ry. The former of these has a projected extension from Sulphur Springs to Ft. Smith, Ark., 107 miles, which may be completed within a year or two, and the latter is doing something toward the construction of its proposed line from Beebe, Ark., to Monroe, La. In Missouri a somewhat ambitious project is being pushed by the Springfield, Sedalia, Marshall & Northern Ry. Co., which proposes to build a line from Springfield to Miami, Mo., 150 miles, and ultimately 110 miles further north into Iowa. Nothing but the surveying has been done yet but the promoters express great faith in being able to do some construction soon. Several of the lines of considerable length and more or less doubtful financial standing shown on our previous maps of Texas have been excluded from the present figures. Among the newer schemes the most noticeable is the Pan American Ry. Co., which has built ten miles south from Victoria, Tex., and has about 225 miles more surveyed and projected, taking its line to Brownsville, Tex. Work is now discontinued.

The several short lines of a local character upon which work is in progress are sufficiently described in the detailed list. These are in all stages of progress, in many cases well on toward completion, and will add considerably to the tracklaying of the year.

THE CHICAGO FOUNDATION QUESTION.

It is not sufficiently realized, we think, how many causes there are at work in Chicago tending to make the greatest concentration of business activity on a very limited area which the world has ever seen. We might go further, perhaps, and say that this degree of concentration had already come about; but great as it is now, it is yet to be much greater, and city councils and insurance organizations might as well try to keep back the Atlantic with a broom as to stop this concentration by edicts against tall buildings and what not, until the limit of physical possibility has been reached.

It is this point of view which makes the Chicago foundation question one of extreme importance, and yet, so far from there being general agreement as to what ought to be done in the way of permitting very high buildings, there is not yet general agreement as to the facts in regard to the natural foundations on which these buildings must rest, which is one of the main elements necessary to determine the possible height of buildings. There has been some formal action lately, which we have duly chronicled, tending to put a stop to the construction of such buildings, but that this action can be only temporarily effective, and that very high buildings will be and must be built, we think is clear from a very brief examination of the real facts.

Twenty years from now the four great cities of the world are likely to be in the order named, London, New York, Chicago, Paris, each, perhaps, with over 3,000,000 inhabitants. Possibly Chicago may even then outrank the nominal New York, though it can hardly outrank the real New York for half a century at least. Of these cities New York only has natural limitations as to its total area, and hence that part of New York which is on Manhattan Island will be likely to show then, as it does now, the greatest density of population on its entire populated areas. But the very cause which tends to produce this, the long and narrow shape of the island, tends to prevent that terrific concentration of business activity on a small area which not only cometh but now is in Chicago.

Why this should be is easily enough seen, and yet we have never seen it noted. The great traffic arteries of New York are three: Third Ave., Sixth Ave. and Broadway, the first two already provided with fair rapid transit facilities, the last as yet not so provided but likely soon to be. These arteries, as also the secondary lines of Second and Ninth Ave. run the entire length of the island, and one or more of them is conveniently accessible to every person living on the island, as they will soon be also to every person living in the "annexed district" north of the Harlem.

As a consequence, any business center which develops at any point of these lines (which below 53d St. converge and draw reasonably close to each other) is conveniently accessible to the entire population, and the necessity of concentrating at the terminus of these lines in order to be thus accessible to the whole population is done away with. Hence has come about a segregation of business interests which is peculiar to New York, which is still increasing, and which can exist in like degree in no other city but one of similar shape. At the lower end of the island the shipping and heavy importing interests are concentrated; there is little else there. Then comes the Wall St. monetary district; there is little else there. Then comes on one side of Broadway the jewelry and light metal-working trades, and on the other side of Broadway the heavy machinery and manufacturing trades. Then comes the great office and printing center, which extends downward along Broadway to Wall St. but which stops short at Chambers St. and the City Hall Park on the north. Then comes the great "dry goods district," which extends from Chambers St. to about 10th St., within which district almost every wholesaler of dry goods and "notions" in the city is to be found, and practically nothing else. Then, in a district wholly by itself and miles away from the financial and office centers and centering on 14th and 23d Sts., comes the great retail district. All the large retailing stores of the city are confined to this district, except a few on Grand St., an east side center for the poorer classes and North Brooklyn, and a few dealers of men's wearing apparel who naturally crowd into the lower part of the town to some extent.

Then comes the great hotel and theater section, centering between 23d and 42d Sts. All the leading theaters of the city not already in this district are likely to move into it soon. As it is, there are only three theaters and two hotels of any prominence so far down as 14th St., all of them relics of the past. The hotel center shows a strong tendency to move up even above 42d St., or close to the residence center, which is already above 42d St. and will soon be above 57th St., constituting the last great belt of the city. Nearly all the clubs also are now above 34th or immediately below it.

And every person who lives or finds himself within any one of these belts is within easy access of the other by quick means of communication. Why then should they crowd together? We allude of course to "vertical" or longitudinal crowding. There is a good deal of lateral crowding, in order to get close to the main arteries of communication. All the districts we have enumerated are narrow; practically confined between Third and Sixth Aves. The marginal districts to the east and west of these are of far inferior value and are given up to tenements and cheap residences, heavy manufactures and storehouses.

A certain amount of this segregation of allied interests is to be found also in London and Paris, for the reason that there is another motive for such segregation than that of finding a location accessible to everyone; that, namely, of getting close to leading houses in the same line, so as to attract more customers and facilitate business with each other; and this motive, which has had perfectly free scope in New York and done its perfect work, has had some effect in London and Paris, so that they stand in this respect about midway between the two extremes of New York and Chicago. But that the segregation is very imperfect in the European cities is evidenced by the fact that the three great dry goods establishments of Paris are in as many different quarters of the city and miles away from each other. The financial and some other interests, however, are pretty well concentrated in both cities.

But in Chicago there is no such segregation of any large interest whatever. Shipping, finance, dry goods, offices, theaters, hotels, clubs, railway stations, warehouses, retailers, wholesalers and every other large interest, are jumbled together on a very small area. Clerks, bank messengers, draymen, ladies shopping and what not are crowded all together in this district, the broad sidewalks of which are already as crowded in the busy hours as those of either London, Paris or New York, and growing yearly worse. Of course there is some little segregation of special interests in single streets, but in the main the whole constitutes one district.

As Chicago has all Northern Illinois to grow over, the greater part of which is enviously alleged to be already included within the city limits and cut up into city lots, and as the city does actually cover an enormous aggregate area, why should this be?

The reason is not far to seek. In the first place every city which has a chance to spread out equally in all directions can have but a single district which is conveniently accessible to all its residents, the small district at its center from which its lines of communication radiate. Therefore, every business interest which wishes to be accessible to every one—and what interest does not?—must seek a location in this small district, which is only a point, so to speak, instead of a line as in New York. Nevertheless, when there is no physical line of demarcation to make patent the fact that one is either in or out of the swim, considerations of economy will lead persons to choose locations just on the edge of the chosen district, and thus establish a gradually expanding fringe which in the end will cover a considerable area in the more attractive directions for expansion.

Both of these opposing tendencies are strikingly exemplified in London and Paris. The great centers of those cities are upon the immediate banks of the Thames or the Seine; yet these rivers—albeit spanned by innumerable bridges—have acted as a Chinese wall against any extension of the larger interests across them. To go across them was openly to confess oneself inferior and second class. It has been preferred instead to go much further off if it was only on the right side of the river, and a great fan-like development on that side of the river has resulted in consequence, which has gone so far that the outlying business districts do not and cannot pretend to serve more than half of the favored half of the city.

But even this much chance for gradual expansion from the center without confessedly moving out of it is denied to Chicago. Its business center is forever defined by nature as consisting of a little district about one-half mile square or 160 acres in all, bounded on the north and west by the Chicago River, on the east by Lake Michigan, and on the south by the railway stations in part, and in part by the (far more patent) walking limits from the terminals of the north side and west side means of transit. Within this district any business establishment may claim to be conveniently accessible to every resident of or visitor to the city. Outside of it, by however little, one is conveniently accessible only to the north side, west side or south side resident; and as one can then serve only one of these districts at best, there is a natural tendency to serve that as well as possible and ignore the others altogether, and accordingly subsidiary business centers to serve one district are developing in each of the three great districts of the city, as at 23d St. on the south side, which are far removed from the main center of the city, and make no pretense to be "in it."

To obviate these and other difficulties there has been some suggestion at various times to abolish the Chicago River altogether, utilizing its bed for sunken railway tracks, and discharging its waters through artificial channels far to the south of the city, where also a new harbor and lumber yards were to be built. But this is not likely ever to be done, and even if done it would not change the existing status in question. The river bed would still be there constituting a natural boundary line of business section; the cost would be enormous and the heavy landed interests of the business center would be certain to oppose the proposition if it went so far as to fill up the river bed altogether. The lower half mile of the river, constituting the northern boundary of the business section, would almost certainly be retained in any case, for use as a harbor.

Hence existing conditions are never likely to be materially changed. From the necessities of these conditions, and not from its exuberant enterprise and bumptiousness have come the high buildings of Chicago which throw those of New York in the shade, have come the second, third and fourth story streets (as they practically are) with independent retailing establishments opening upon them, and all the other evidences of an intense congestion of business activity. All the relief which can be found by high buildings is certain to be demanded, and it is hopeless to contend against it.

It is more than likely that within a few years second story sidewalks will come into vogue to relieve the main sidewalks and save the risk of crossing the broad streets, crowded with street cars and vehicles; for it is notable that, with all the street cars, they play very little part in communication about the business section. They merely terminate in it, and leave walking as the chief available means of transfer from point to point in the business section.

It is an unfortunate concomitant of this situation that the quality of foundations in the business section is at least dubious, if not untrustworthy. According to the heretofore accepted idea under which most of the heavy buildings so far built have been planned they are very untrustworthy, the whole business section having been assumed to rest upon a thin upper stratum of stiff clay, not more than 12 to 20 ft. thick in all, the top of which (the original surface of the city) is some five feet above the lake level, and the bottom of which rests on 40 to 80 ft. of much softer and more fluid clay or muck. Accordingly, in most of the large buildings of Chicago, this upper clay has been very gingerly handled, all cutting into it being carefully avoided, and a brand new and admirable though expensive style of steel rail and I-beam foundation invented to spread the load over most or all of the area of the building.

The alleged danger of breaking through this upper crust has been one of the strongest reasons advanced for forbidding the construction of any more such high buildings. Those who have already built and own high buildings seem to be especially alive to this danger and anxious that no more shall be permitted, and through that and other influences some official action has already been had looking toward the prohibition of more high buildings.

There is no denying that, although a single isolated high building gets better light and air than any other, the building of continuous blocks of such buildings tends to convert the streets into tunnels (especially when they have a roof of black smoke) and to complicate greatly the question of fire protection, safety against explosions or earthquakes and sidewalk room as well. If there were any possible way of escaping from the necessity of such buildings, as there is in most cities, it is altogether probable that the objections to them would be decisive and their permitted height strictly limited.

But as we have seen, there is no way of escape from them, other than of physical possibility, however much the citizens may wish to avoid them. Temporarily, opposition may be effective, but it is as certain as any event of the future can be that inexorable necessity will conquer in the end. The whole business center must and will be covered with buildings. In no other way can room be found for the business interests which have no other suitable spot to gather on. Chicago is not going for long to check its own growth; and that is what it will mean when more room for centrally situated offices and stores can no longer be had except at prohibitory rents.

It is therefore a matter of no small moment that all the latest information seems to indicate that the foundation problem is not really so grave as it seemed; that there is really a fairly solid bed of clay all the way down to rock, and that the rock itself or the hard pan overlying it, can be reached almost everywhere at no great increase of cost over the present rather expensive foundations. Two papers which we reprint in another column go far to establish this fact, all the more because one of them was written to controvert the other; for as to the nature of the foundations they agree, though they differ in their ways of treating them. Gen. Sooy Smith proposes to carry all foundations down to rock and to use stone instead of iron columns. Mr. Guthrie and the others quoted disagree with him in both these suggestions, but agree that good foundations for any required building can be had. The truth is, perhaps, that the substratum of Chicago is neither so good nor so bad as has been painted and that great care will always be needed and occasional failures will occur; but that it is going to be necessary to check the growth of Chicago's business section in the only direction in which it can grow, "higher up," we do not believe.

THE CEMENT "BACILLUS."

Dr. Wilhelm Michaelis, the well-known cement expert of Berlin, announces in a pamphlet sent us the discovery of a "cement bacillus," so to speak, an extremely minute object that appears by "pure cultivation," but is extremely dangerous to the good qualities of cement under certain conditions. This is the double salt formed under the influence of sea water or saline solutions containing sulphuric acid or gypsum water. Dr. Michaelis suspected this double salt of lime, alumina, sulphuric acid and water of crystallization as early as 1883, but owing to its microscopic nature he had not recognized it as a crystalline compound, even when magnified 200 times. He gives the credit of this discovery to Mr. E. Caudlat, engineer-chemist of the Society of French Cements, who by slowly crystallizing a saturated solution obtained crystals large enough to be distinguished by the naked eye.

Dr. Michaelis then experimented by introducing sulphate of alumina into a saturated solution of lime-water, and subjected to a careful microscopic examination the precipitate after it had been exposed for a considerable time to the action of the saturated lime solution. He found that the voluminous flocculent substance present consisted entirely of small needle-like crystals. He dried them over sulphuric acid and found them to correspond to the formula of Mr. Caudlat:

$$Ca_3\,Al_2\,O_6 + SO_4 + 30HO$$

He then dissolved this apparently formless double salt in boiling water, excluding carbonic acid, and obtained from the solution the same distinct crystallization of the salt as Mr. Caudlat had obtained by his process. This aluminic-calcic sulphate, or more correctly, calcic-aluminate and sulphate, forms when produced this way needle-shaped prisms up to 0.5 mm. in length and from 0.02 to 0.05 mm. in breadth. These are the "bacilli" referred to, and it can be readily understood that in crystallizing in the hardened cement with such a great increase of volume they should be able, notwithstanding their infinitesimal size, to destroy its cohesion.

Since most Portland cement contains 7 to 9% of alumina and can therefore take up from 28 to 36% by weight of dehydrated gypsum, or 60 to 80% of calcia sulphate and water, the powerful influence exerted on cement by solutions containing sulphuric acid is no longer remarkable. A continuously saturated solution of gypsum is in the same manner destructive to cement, for, as regards the amount of contained sulphuric acid it is about equivalent to sea-water. Dr. Michaelis says, on the other hand, that the formation of this double salt in cement explains why a certain limited addition of gypsum to Portland cement increases the compactness and hardness of the latter. It increases its density and must thus enhance the strength so long as the crystals find room for themselves without violent destruction of cohesion.

He has fixed by exhaustive study and observation the limit of safety, in the addition of gypsum, as high as 4% by weight for many Portland cements, or about 2% of sulphuric acid. This is about twice as much as is permitted by the German Cement Regulations. It is understood that this percentage will vary with the sulphuric acid compounds present in the cement-clinker. He says it is quite a mistake entirely to forbid sulphuric acid in cement, as has recently been done. The danger to the cement lies not so much in the sulphuric acid already contained in it as in sulphuric acid acting upon it subsequently, from without. To crystallizing compounds alone can be attributed the violent destruction of cement, says Dr. Michaelis, and he doubts any destructive effect from basic calcic-sulphate or calcic-ferrate and calcic-sulphate until some one can produce these bodies in well defined crystals, as has been undoubtedly done in the case of the "bacillus" of calcic-aluminate and calcic-sulphate. Dr. Michaelis has very lately sent a paper on the "Behavior of Portland Cement in Sea-water" to the Institution of Civil Engineers, and we expect to publish an abstract of this in an early issue.

A two-cylinder compound ten-wheel locomotive has been built by the Pittsburg Locomotive Works, Pittsburg, Pa., for the Pittsburg & Western Ry. It has cylinders 19 × 26 ins. and 29 × 26 ins., driving wheels 4 ft. 4 ins. diameter, and weighs 135,000 lbs.

LETTERS TO THE EDITOR.

A PROBLEM IN RAILWAY LOCATION.

Sir: Will some of your readers give short formula for determining trigonometrically the following:

Given two straight lines diverging from each other at a known angle. Let the distance be known from any selected B. C. of reverse curvature of given radii on one of the lines to the intersection with the other line measured along the direction of its radius. Let the distance from this intersection to the E. C. of the reverse curve along that given line be the distance sought, determining also the central angles of each curve in the reversal.

The preceding is useful in running in track cross overs, and in selecting the extremities of reversals of given radii prior to running in the curves.

Location.

INCORPORATING TRADE UNIONS.

Sir: In reference to Mr. Chauncey F. Black's proposal in the "Forum," which you commented on in your issue of Sept. 8, you may be interested to learn that something of the kind has been successfully carried out in England.

The particulars are given in the evidence before the Parliamentary Labor Commission now sitting and are referred to in the September number of the "Contemporary Review," by Mr. John Rae (p. 326).

The essence of Mr. Black's proposal seems to be fully carried out, but it is by a Trade Union—not a separate corporation—and this is in some ways distinctly preferable. It is said to work exceedingly well, but it seems to be admitted that it cannot be expected that trade unions generally will assume such responsibility of their own motion and therefore some men in other trades are now urging that trade unions should be obliged to do so by a general law.

Yours faithfully, H. D. P.

London, England, Sept. 21, 1892.

DEPTH ON THE CHARLESTON BAR.

Sir: In your issue of Sept. 15 is an item on the first page to the effect that the U. S. Revenue steamer "Morrill" reported a minimum depth of 14 ft. 6 ins. on the bar on Aug. 26. When a depth is quoted it is usually supposed to have been reduced to the datum of mean low water as a basis of comparison. This statement, therefore, would indicate a remarkable and sudden increase of nearly 5 ft. after fifteen years of progress; but it appears that the tide was only about one-half of a foot from flood at spring tide, or about 5 ft. above the datum. The corrected depth is therefore about 9½ ft., which is a loss and not a gain. The actual stage of water should be corrected for direction and force of wind, as some tides are over 10 ft. above the datum. As such statements are misleading and do not accord with the facts, they should not go unchallenged by those who are most familiar with the actual conditions of these works. We should be glad to know the truth as to the actual results obtained by the jetties aided by dredging at the Charleston entrance, since we have taken the ground that the plan is defective and unable to produce the desired results which it was predicted* might reach a "maximum depth of 75 ft. and upward."

Lewis M. Haupt.

Philadelphia, Oct. 1, 1892.

* Report Chief of Engrs., 1878. Part I., p. 564.

"ASPHALT."

Sir: Having once conversed with you upon asphalt and its natural and artificial compounds, I venture to write a word to say that there is no authority, other than of M. Leon Malo, and those who have directly or indirectly used his nomenclature, for calling the natural compound of limestone and asphaltum by the name "asphalte" or asphalt. I notice in Engineering News of Sept. 29, 1892, an attempt by correspondents to show that no objection was made until 1888 to the term "asphalte" as meaning asphaltic or bituminous limestone. This is not true as far as Europe is concerned, and probably not true of the United States. In Germany and Switzerland, and even in France, and elsewhere, among engineers and writers upon the subject, there has been no misunderstanding. Asphaltic limestone (French, "calcaire bitumineux"; German, "bituminoser Kalkstein), in connection with paving, has often been called rock asphalt (German, "asphalt-stein") for the sake of convenience and brevity. In France, through the influence of the writings of M. Malo and for the sake of brevity, the word "asphalte" is used by the public to indicate street and sidewalk surfaces. Engineers and contractors in France are careful to say "asphalte comprime" for street surfaces of compressed powdered asphaltic-limestone, and "asphalte coule" for a mastic composed of asphaltic limestone, made more asphaltic by the addition of Trinidad or other asphaltum.

In the United States the Trinidad asphalt paving mixture, made of asphalt, sand and limestone, is called for brevity by the public, simply "asphalt pavement." Trinidad asphalt, as obtained crude, is not pure asphalt or asphaltum. It contains almost 65% of water,

earth, etc. The list of authorities in German, French and English is very long and known to all engineers and chemists who have investigated the subject; showing beyond a doubt that "asphalt" has always been regarded as one of the hydro-carbons and as belonging to the group of bituminous substances. Moreover, it is found in nature not only in a native state, but also mixed by physical, not chemical, combinations with clay, sand, limestone and other substances.

Hoping that I have not intruded upon your time and space, I remain, Your obedient servant,

J. W. Howard, B. L., C. E.

New York, Oct. 4, 1892.

THE RECENT NEW YORK CENTRAL BRAKE TESTS.

Sir: As the result of the brake trials made by the New York Central in Albany, on Sept. 8, 9, and 10, Mr. Webb gave us the following letter with full permission to publish the same. You will notice that these reports place the two brakes on an equal footing in every respect.

Yours truly, C. A. Starbuck,
Vice-President New York Air Brake Co.

Mr. Royal C. Vilas, President New York Air Brake Co.

Dear Sir: Replying to your letter of last week, I would state that a full and detailed report from Mr. Dudley on the tests recently made by us of your automatic quick acting brakes will not be ready until some time in October. I have, however, a preliminary report from Mr. Dudley, and also reports from Mr. Voorhees, our General Superintendent, and Mr. Buchanan, our Superintendent of Motive Power and Rolling Stock, both of whom were present at the tests.

The gist of these reports is that, from a practical operating standpoint, there is no difference between the operation of the Westinghouse air brakes and the air brakes of the New York Air Brake Co.; and the tests where the cars in the train were mixed, a portion being equipped with the brakes of one company and a portion with the other, showed as good results as when either brake was used separately.

We are satisfied that there are no practical objections to allowing the cars equipped with the New York brake to be used in conjunction with those equipped with the Westinghouse brake. I have, therefore, issued orders removing all restrictions as to the use of cars equipped with your brakes; and, hereafter, cars so equipped will be received and operated by this company and treated precisely the same as the cars equipped with the Westinghouse brake. Yours very truly,

New York, Oct. 8, 1892. H. Walter Webb.
Third Vice-Pres. N. Y. C. & H. R. R. R. Co.

(We assume that the New York Central officials consulted with the committee on air brake tests of the Master Car Builders' Association before making their tests or expressing the above opinions upon them. The experience which has been gained during the past year in the matter of brakes has shown certain features of triple-valve construction to be essential to the safe handling of air braked trains that have not heretofore been clearly understood. It is, for example, essential to safe interchangeability that all triple-valves should have substantially the same degree of sensitiveness to changes of pressure in the train pipe, in order that uniform application and release of brakes may occur throughout the train. This point was well shown by Mr. G. W. Rhodes, Chairman of the Committee on Air Brake Tests at the last convention of the Master Car Builders' Association (Proc., p. 171). The report of the committee, presented at that convention, showed that rack tests were not only easier to make than brake tests, but were much better suited to testing the action of the triple-valve.—Ed.)

NOTES AND QUERIES.

A. S. H. asks concerning the actions of sea-water on lead, lead-pipe, or on the lead joints of cast iron pipe, immersed in salt water? We have looked in vain for any recorded experiments under this head. In a general way and according to the opinion of an experienced chemist of this city, it may be said that lead, in a metallic state is not easily affected by chlorides, when dilute or cold, nor by muriatic acid. But it is readily converted into a chloride when in contact with a solution of muriatic acid even as dilute as in sea-water, and exposed to the air alternately. Chloride would then form abundantly, and probably be washed off again each time it was immersed, and thus expose a new surface to attack. But it is reasonable to suppose that constantly submerged in cold sea-water only a thin coating of chloride would form and remain and give a long life to the pipe. There does not seem to be anything else in sea-water to injuriously affect the lead. Even small proportions of bicarbonate or sulphate of lime in water prevent hurtful action on lead, and sea-water contains 1.7 parts of lime in 100 parts of total salts. It has been suggested that a mixture of linseed oil and pitch applied to the pipe would preserve it indefinitely, especially if the lead pipe is wound with cotton strips soaked in the same mixture.—Ed.

THE CAUSE OF CRACKED PLATES IN CAST IRON CAR WHEELS.

One of the most important causes of failure of cast-iron car wheels on mountain roads is the cracking of the plate of the wheel. The cause of the cracking is the unequal heating of the wheel from the friction of the brakes in descending long or steep grades. On the New York, Lake Erie & Western R. R. in 1884 the total number of wheels removed from this cause was 2,121 out of a total removed from all causes of 15,595, and out of a total of about 251,000 wheels in service. Yet, compared with many of the transcontinental railways and many other shorter roads, the Erie grades are

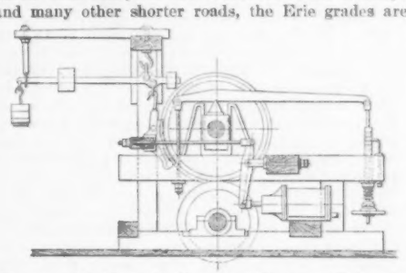


Fig. 1. Machine for Testing Effect of Brakes on Car Wheels.

neither long or steep. It is on the mountain railways that the evil of cracked plates is most serious, and it reaches such proportions there as to give rise to efforts to overcome it.

In the report just published of the late convention of the Master Car Builders' Association is a paper by Mr. H. J. Small, Superintendent of Motive Power of the Southern Pacific Ry., describing experiments made at the Sacramento shops last year to investigate the causes of cracked wheel plates. This information was furnished by Mr. Small to the Committee on Cast Iron Wheels which made a report to the convention at Saratoga last June; but it was received too late for presentation at that time and has just been made public in the printed report of the proceedings. We give the substance of Mr. Small's report as follows:

Experiments on chilled cast-iron car wheels have recently made at Sacramento shops, of the Southern Pacific Co., with the view to determine the cause of the frequent cracking of wheel plates on mountain grades of the Southern Pacific Co., and, if possible, to devise corrective measures to prevent its excessive occurrence.

The experimental machine used in these tests is shown in Fig. 1, and is briefly described as follows:

An 85-HP. Corliss engine furnished power to a secondary shaft by means of a friction wheel, keyed to the shaft and driven by contact with the outer periphery of the engine flywheel. On this secondary shaft were keyed two 25-in. friction rollers, spaced 4 ft. 8½ ins. apart. These friction rollers imparted their motion to the pair of 33-in. wheels to be tested, which were mounted on an axle with journals running in M. C. B. journal bearings and boxes, having free vertical movement in a pair of M. C. B. pedestals, inverted on horizontal cross beams. The pressure on the journal was effected by means of levers and graduated springs, and was regulated to exert a pressure of 5,000 lbs. on each journal. Brake pressure was obtained by a 10-in. air cylinder and piston, and was transferred by a suitably arranged lever to a standard brake beam set below the center line of wheel. Brake shoes were mounted in the usual way on the brake beam, and were brought to bear directly against the wheel to be tested. The air pressure was controlled by an engineer's valve, and also directly by a pump and reservoir. The testing machine, so completed, was the nearest approach that could be obtained to the actual conditions in service, the only variation therefrom being that the friction rollers acted as motive power. The air cylinder pressure was doubled by leverage so that the pressure on each shoe was equal to the total pressure in the air cylinder, less the resistance of cylinder spring and piston friction, which were not taken into account.

After a few preliminary experiments, which were made to obtain some idea of the pressure necessary to cause the cracking of wheels, the following standard test was adopted and continued through these experiments:

The velocity of the wheels to be tested was regulated to 306 revs. per minute, corresponding to a train speed of 30 miles per hour, and was maintained for a period of 45 minutes. A gage pressure of 10 lbs. per sq. in. air cylinder area, equal to 785.4 lbs. on each shoe, was used at the beginning of the test. This pressure was increased 5 lbs. per sq. in. at intervals of five minutes, thereby causing successive increments of pressure of 392.7 lbs. each, to be added to the original, until the final gage pressure of 50 lbs. per sq. in. was reached, corresponding to a shoe pressure of 3,927 lbs. Cast iron shoes were first used, and after failure to crack the wheels subjected to test with them, wrought iron shoes were substituted in their places, and the test was repeated. The principal notes taken were the temperature of the wheel at rim and hub at the end of each test, and the retarding strain on the brake shoe in the direction of the revolving wheel, which strains were recorded by means of hangers fastened to the brake shoes, and to a scale beam.

In connection with the above described testing machine, a heating apparatus was used, modeled after a tire expander, for the purpose of determining the effect of heating the rim of a car wheel by direct heat, instead of by heat produced by friction. The wheel was surrounded for two-thirds of its circumference by a coil of 3-8-in. pipe, returned on itself, both coils being on the same plane; kerosene oil entering by gravity at the bottom of the inner pipe passed up both sides and returned through the inner pipe. The outer pipe had 1-16-in. holes, 1 in. c. to c., on its inner side, through which the oil issued. The pipes were surrounded and held in position by a sheet-iron casing, 8 ins. larger in diameter than the wheel and secured by clamps to the rim of the wheel, fitting the former closely; the inner pipe, being directly in the flames from the orifices of the outer pipe, caused the oil flowing through the former to soon become volatilized, and to issue from the orifice and burn as a gas, and thus impart heat to the rim of the wheel. The temperature of rim and hub were taken, as in the brake test, by immersing a thermometer bulb into holes filled with mercury. A low hub temperature was maintained by a current of water flowing through the core space, the core holes having been provided with wooden plugs for the reception of water pipes.

The first series of tests with the brake test machine was made on wheels cast at the foundry of the Southern Pacific Co., at Sacramento. There were 16 tests made on ten pairs of wheels. The results obtained from these ten pairs of wheels are shown in Table I. The wheels are arranged in the order of their values, the poorest being first.

This table indicates that strengthening the wheel at the weak point in the hollow face by the different

Table I.—Brake Shoe Tests of Wheels Cast at Southern Pacific Co's Sacramento Shops.

	Shoe.	Time of Test. Min.	Difference between temperature of rim and hub. Degrees. North Wheel.	Degrees. South Wheel.	Condition at End of Test. North Wheel.	Condition at End of Test. South Wheel.
Std. 580 lb., ¾-in. plates	Cast	45	222	219	Outside plate cracked	Outside plate cracked.
Std. 580 lb., ¾-in. plates	Cast	45	236	235	Outside plate cracked	Outside plate cracked.
Std. 580 lb., ¾-in. plates*	Cast	45	254	244	Outside plate slightly cracked	Outside plate cracked.
Same, with short outside ribs	Cast	45	250	270	Sound	Sound.
Same, with short outside ribs	Wro't	35	280	509	Outside plate cracked	Outside plate cracked.
Same, with ¼-in. metal added to hollow in face of wheel	Cast	42	324	281	Outside plate cracked	Both plates cracked.
Same, with S shaped brackets	Cast	45	339	312	Sound	Slightly cracked.
Same, with S shaped brackets	Wro't	30	335	312	Outside plate slightly cracked	Outside plate cracked.
Same, with ribs in core	Cast	45	339	277	Sound	Sound.
Same, with ribs in core	Wro't	35	328	345	Outside plate cracked	Outside plate cracked.
Single pl. 645 lb. eng. truck wheel.	Cast	45	277	272	Sound	Sound.
Same,	Wro't	30	350	350	Cracked	Sound.
650 lb., ⅞-in plate, ribs in core	Cast	45	332	296	Sound	Sound.
Same,	Wro't	45	364	404	Outside plate cracked	Outside plate cracked.
650 lb., ⅞-in. plates	Cast	45	292	261	Sound	Sound.
Same	Wro't	45	364	403	Outside plate cracked	Outside plate cracked.

* Cast in a Canda contracting chill.

methods indicated above, adds slightly to the strength of the wheel. The wheel made in the contracting chill gives the same results as those made in the ordinary chill. There were enough of the "S" bracket wheels tested to show that a wheel with this form of bracket is more capable of resisting high temperature than a wheel of same pattern with the standard bracket. The three pairs of heavy wheels, one pair single plate and two pairs heavy double plate wheels, give the best results, the heavier double plate being able to resist a heavier strain.

The next series of tests was made on 28 foreign wheels, including 42 different makes. Table II. shows the relative value of these wheels. It also includes the average of four steel, 580-lb. Sacramento wheels and two 650-lb. Sacramento wheels. The wheels are arranged according to the difference of rim and hub temperature, the poorest wheels first.

Table II.—Brake-Shoe Tests on Cast Iron Wheels of Various Makers.

Wh'l.	Date of make.	Brake shoe.	Time of test. Min.	Difference of temperature rim and hub. Deg.	Condition of wheels at end of test.
QN	1882	Cast.	26	180	Cracked.
GS	1890	Cast.	45	228	" Sac. wh. 580 lb.
NN	1886	Cast.	43½	242	Outside plate crk'd.
SN	1882	Cast.	32	260	" " "
KN	1888	Cast.	46	290	Sound.
KN	1888	Wrought.	32	263	Outside plate crk'd.
KS	1888	Cast.	46	291	Sound.
KS	1888	Wrought.	32	300	Outside plate crk'd.
LN	None	Cast.	41	311	Out. pl. badly crk'd.
LS	1890	Cast.	45	330	Outside plate crk'd.
QS	1888	Cast.	26	249	Sound.
QS	1888	Wrought.	34	331	Outside plate crk'd.
RS	1888	Cast.	32	2.9	Sound.
SS	1888	Wrought.	34	331	Outside plate crk'd.
ON	1889	Cast.	45	336	Cracked.
TN	1888	Cast.	45	338	Outside plate crk'd.
PS	1887	Cast.	45	333	Sound.
PS	1887	Wrought.	41	345	Both plates crk'd.
WN	1890	Cast.	45	353	Cracked.
WN	1890	Wrought.	38½	292	Broken.
RN	1889	Cast.	45	343	Outside plate crk'd.
US	1888	Cast.	45	340	Sound.
UN	1888	Wrought.	42	381	Outside plate crk'd.
ES	1890	Cast.	45	276	Sound (Sac. wheel).
ES	1890	Wrought.	45	283	Crk'd (650 lbs. T. S.)
LS	1881	Cast.	41	277	Sound.
LS	1881	Wrought.	29	382	Outside plate crk'd.
VN	1888	Cast.	44	384	" " "
MN	1888	Cast.	45	3-5	Sound.
MN	1888	Wrought.	39	415	Outside plate crk'd.
JS	1885	Cast.	45	315	Sound.
JS	1885	Wrought.	40	434	"
JS	1885	Wrought.	29	367	Outside plate crk'd.
OS	1888	Cast.	45	326	Sound.
OS	1888	Wrought.	43	443	"
OS	1888	Wrought.	41	389	Outside plate crk'd.
MS	1889	Cast.	45	330	Sound.
MS	1889	Wrought.	39	463	Outside plate crk'd.
TS	1888	Cast.	45	298	Sound.
TS	1888	Wrought.	44	468	Outside plate crk'd.
US	1885	Cast.	45	324	Sound.
US	1885	Wrought.	42	364	"
US	1885	Wrought.	45	474	Outside plate crk'd.
PN	1881	Cast.	45	320	Sound.
PN	1881	Wrought.	41	395	"
PN	1881	Wrought.	44	457	"
PN	1881	Wrought.	45	476	Inside pl. crk'd, ribs.
VS	1888	Cast.	44	317	Sound.
VS	1888	Wrought.	43	489	Outside plate crk'd.
WS	1890	Cast.	45	296	Sound.
WS	1890	Wrought.	38½	317	"
NS	1885	Cast.	43½	291	"
NS	1885	Wrought.	29	310	"
NS	1885	Wrought.	41	400	"
JN	1887	Cast.	45	328	"
JN	1887	Wrought.	49	210	"
JN	1887	Wrought.	29	410	"

Table III. shows the results of tests of wheels in the rim heater:

TABLE III.

Time of test.	Difference between rim and hub temp.	Condition at end of test.
20 min.	288°	Outside plate cracked.
30 min.	400°	Outside plate cracked.
30 min.	400°	Outside plate cracked.
40 min.	484°	Outside plate cracked.
40 min.	650°	Sound.

It appears from a comparison of the Tables II. and III. that the cracking of the wheels is mainly due to the difference in temperature of rim and hub. That the wheels cracked at a lower temperature in the

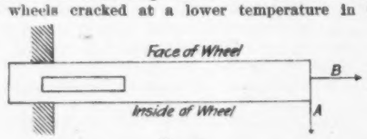


Fig. 2.

brake test machine than in the rim heater is probably due to the fact that the pounding and secondary stresses caused by brake pressure, pressure on rail and centrifugal force, start the crack which is induced by stress coming from difference in temperature before that stress has reached the limit of the ultimate strength of the iron.

The most noticeable fact of the tests was that the cracks almost invariably started in the same place, i. e., in the outer plate, within the junction with the inside plate. This brings up the question of the direction of the stresses causing those cracks. The forces are so various in the wheel under test that it is impossible to consider all of the resulting stresses; but the most important stresses seem to act as follows: With the usual pattern of wheel, when the rim is expanded by breaking, a force outward acts about in the plane of the middle of the single plate. On one side of this single plate, the outside of the wheel, there is not sufficient metal to resist the expansion of the rim; on the other side the rim is bound to the hub by brackets; these brackets being exposed on three sides to the air, and fanning the air very rapidly, are favorably situated for remaining at a lower temperature than corresponding parts in the single plate. In these tests it was observed that the ribs kept at a lower temperature than the main part of the wheel at an equal distance from the rim. The effect of these comparatively cool ribs resisting the expansion of the rim of the wheel on one side of the single plate, there being no resistance on the other, would be to prevent the diameter of the tread of the wheel next to the flange from increasing so much as the outside of the tread of the wheel. There is a second resisting action in the expansion of the flange side of the rim, and that is due to the fact that the metal in the flange is considerably colder than the part of the rim of the wheel which is in contact with the shoe. It has been found that the shoe when at a red heat, probably at a temperature of 2,000°, only caused a temperature on the inside of the rim of about 600°, the bulb of the thermometer being less than ½ in. from where the red-hot shoe was in contact with the wheel a few seconds before. This would bring the main stresses in a radial section of the wheel down to the following case: (See Fig. 2.)

A beam fixed at one end, i. e., the hub, and a load applied at the outer end, and also a force acting horizontally outward, would bring the greatest strain in the top of the beam next to the support, i. e., in the outside plate of the wheel. The cause of the crack occurring at the particular position at the junction of the plates is also due to the fact that at this point the metal is usually dirty, or full of blow holes, the dirt often extending to three-fourths the depth of the plate metal. If the above comparison of a beam be true, the way to counteract the force A would seem to be as follows: To put the metal in a position to have the stresses due to the expansion of the rim act uniformly throughout the plates, and not at one point in one plate, as in the case of the beam fixed at one end and loaded at the other.

The first way which suggests itself is to put less metal in the ribs, either by decreasing the number of ribs, or else their size; and, second, to use the "S" form of bracket, as it takes less force to extend the length of these than of the straight curved brackets. A third way of resisting the action would be to extend the single plate nearer to the outside of the rim of the wheel.

The concave form of outside plate would seem preferable to the convex form, as it does not offer the sharp curves at the junction of the plates to start the cracks on. A study of the form of the Sacramento and foreign wheels tested bear out the above theories. The wheel standing the highest test, JN, embodies, undoubtedly, the best principles of wheel design: This wheel has thirteen small brackets, ⅝-in. inside plate (full of blow holes) and ⅞-in. outside plates, the latter being of a concave form.

In regard to the Sacramento wheels: It is shown in the first table that the heavy 650-lb. wheel is much better able to resist the heating action than the standard wheel. The heavy Sacramento wheel was modified according to suggestions by an expert wheelmaker, the main change being the addition of metal to the ribs, making the original wheel weigh 680 lbs. This wheel when tested in the rim heater stood only the same test as a Sacramento standard wheel, and below the test of the 650-lb. wheel tested in the brake test machine. The wheel of modified pattern, made at Sacramento from the design weighing 615 lbs. rough, or 578 lbs. finished, stood a much higher test in the rim heater. This pattern of wheel was also tested in the brake test machine, the wheels cracking at a temperature slightly below that of the original pattern.

The wheel which gave best results, JN, was carefully compared with the Sacramento wheels to find the relative excellence of the metal in the two wheels. Rectangular sections cut from each showed an average tensile strength of 20,596 lbs. per sq. in. for the JN wheel and 22,190 for the Sacramento wheel. By the Pennsylvania drop test a wheel of the same make as the JN wheel cracked on the 7th blow and broke on the 15th. The average of a large number of Sacramento wheels broken by the Pennsylvania test during the past six months is: Cracked at 7⅘ blows; broke at 11⅘ blows. These two sets of tests indicate that the materials of the best wheel, JN, and the Sacramento wheels were nearly alike.

The next to the best wheel, NS, stood 36 blows in the Pennsylvania test before cracking, and broke on the 49th blow, the cracks starting in burnt checks in the chill.

It is fair to assume that NS would have stood a good many more blows if it had been subjected to the drop test before undergoing the brake test. This may be seen by the fact that the two wheels JN and WS both cracked on the 2d blow and broke on the 8th and 4th blows respectively; whereas a wheel of the same make that had not been heated previously, cracked on the 7th blow and broke on the 15th blow.

A study of the tensile strength of the specimens from ten of the wheels tested in the brake test machine and an examination of the fractures of these specimens proves instructive. The fractures of the specimens whose tensile strength varied from 23,480 to 21,739 lbs. per sq. in., all show a close grain and light color. Those from 20,596 to the weakest, 18,464, are the reverse in appearance, being dark with large grain and fracture ragged. It is evident from figures obtained that the tensile strength of iron is more dependent upon the degree of hardness than upon the brand of iron used in the cupola. The tensile strength of a test bar poured from the same ladle as the wheel is very little indication of the tensile strength of the material in the wheel, the test bar being usually weaker from the fact that it is much harder and is subjected to internal stresses. A good indication of the safety of a wheel is the appearance of its fracture, and the Pennsylvania test is still better. A wheel which stands a high test in this machine almost always shows a dark, ragged fracture with large grain to the iron.

Brake-Shoe Material.—The best wheel to resist heating having been obtained, it is also important to make this heating as small in amount as possible. This brings up the question as to whether, for the same amount of braking—not pressure—on the wheel, the wrought-iron shoe heats the wheel more than the cast-iron shoe.

Table IV. shows the amount of friction in the different sets of tests, with different pressures. No. 1 gives the figures for cast iron as taken from the Sacramento wheels, and No. 4 for wrought iron on Sacramento wheels. The others are the results reached on foreign wheels.

TABLE IV.

Gage pressure, lbs. per sq. in.	Shoe pressure, lbs.	Cast iron. 1	2	3	Wrought iron. 4	5	6
10	785	.272	.268	.267	.308	.288	.270
20	1,570	.279	.278	.295	.323	.343	.343
30	2,356	.288	.288	.294	.326	.342	.354
40	3,141	.280	.288	.291	.322	.348	.360
50	3,927	.268	.276	.277	.318	.328	.342
Average.....		.278	.280	.284	.319	.330	.333

These figures are not the actual coefficients of friction, but the coefficients as computed from the pull on the eye-bolt, which is considerably greater than the actual friction. It is evident that for the same amount of braking or retardation of the train, less reduction of train pipe pressure is necessary for wrought iron shoes than for cast iron shoes with the present brake rigging; and if the brake levers for the two kinds of shoes were proportioned so that the braking power obtained with cast iron shoes would be equal to that with wrought iron shoes, the same reduction of pressure in train pipe could effectively be used for both kinds of shoes.

Tables V. and VI. show the relative heating effect of wrought and cast iron shoes.

Table V.—Rate of Heating of Wheels with Wrought Iron Brake Shoes.

Wheel.	Total ft.-lbs.	Temperatures, degs. Wheel.	Air.	Diff.	Ft.-lbs. per degree.
JN	97,095,000	526	60	466	208,358
PN	96,922,000	592	40	552	175,583
JS	96,841,000	590	60	500	193,682
TS	93,647,000	568	40	528	177,362
VS	92,829,000	600	57	543	170,956
PN	91,954,000	573	40	533	172,522
UN	90,727,000	493	54	439	206,665
OS	89,905,000	551	57	494	181,994
US	89,206,000	466	54	412	216,519
US	86,174,000	566	40	526	163,829
JN	83,767,000	466	46	420	199,445
JS	83,691,000	474	46	428	195,540
PN	82,211,000	524	48	476	172,712
OS	79,079,000	501	56	445	177,7 6
NS	76,085,000	507	56	451	168,703
MS	72,432,000	559	62	497	145,738
WS	72,157,000	405	46	359	200,994
MN	71,515,000	527	62	465	153,796
PS	68,382,000	431	48	383	178,512
WN	68,000,000	376	46	330	2 6,061
QS	62,254,000	436	48	388	160,448
SS	60,611,000	436	48	388	156,214
KS	53,565,000	408	50	358	149,623
LS	47,320,000	464	56	408	115,980
NS	44,869,000	396	56	340	131,968
KN	41,322,000	366	50	316	130,766
Average	76,637,000			440	173,526

Each table shows the total rise of temperature in each test, and the total foot pounds of work done in it, and dividing the second quantity by the first we have the foot pounds of work done for one degree rise in temperature. It is evident that the higher the temperature to which a wheel was heated, the greater was the number of foot pounds required per degree rise of temperature. This is merely because the hotter a wheel and shoe is, the more rapidly do they give off their heat to the air. On the average the wrought iron shoe heated the wheel one degree for each 173,526 ft.

lbs., and the cast iron shoe absorbed 196,630 ft. lbs. to do the same.

It is apparently true, from this, that with an equal braking power a wheel with wrought iron shoe will get hot faster than a wheel with cast iron shoe. It must be remembered, however, that the same amount of work was done in a shorter time by the wrought iron shoes than by the cast iron shoes, hence the heat produced had less time to be dissipated than the heat produced by the cast iron shoe. Again the average temperature of the wheels in the testing machine was much higher for the wrought shoe tests than for the

Table VI.—Rate of Heating of Wheels with Cast iron Brake Shoes.

Wheel.	Total ft-lbs.	Temperatures deg. Wheel.	Air.	Diff.	Ft-lbs. per degree.
WS	84,019,000	384	54	330	254,603
KS	83,925,000	409	50	359	233,774
TS	83,847,000	400	48	352	238,303
OS	82,995,000	441	59	382	217,264
MS	82,925,000	436	46	390	212,628
US	81,538,000	429	61	368	221,571
JS	81,536,000	443	42	401	203,332
RN	81,157,000	468	58	411	197,462
RS	79,502,000	430	58	372	213,715
KN	78,628,000	424	50	374	210,235
VN	78,277,000	489	35	454	172,416
PN	77,787,000	466	61	405	192,067
UN	77,208,000	454	61	393	196,458
ON	76,925,000	434	59	375	205,120
TN	76,649,000	438	48	390	196,536
PS	76,471,000	441	61	381	201,239
VS	76,377,000	410	35	375	203,653
JN	75,445,000	419	42	377	200,119
MN	75,291,000	439	46	393	191,555
NN	74,426,000	440	50	390	190,836
NS	73,630,000	408	50	358	205,670
WN	71,206,000	442	54	388	183,521
LS	68,226,000	372	59	313	217,964
LN	63,658,000	406	59	347	183,452
SS	41,543,000	336	64	272	152,732
SN	39,046,000	350	64	286	136,594
QS	32,224,000	324	57	267	120,685
QN	30,881,000	260	57	203	152,123
Average	71,619,000			361	196,630

cast shoe tests; therefore, it should require more foot-pounds per degree rise of temperature of the wheel for the wrought shoe tests than for the cast shoe tests, other conditions being equal.

From an examination of the tables it will be seen that for the same retardation of a wheel, the wrought shoe heats a wheel 1.13 times more than the cast iron shoe. At first sight this seems impossible, as a certain amount of work expended in friction is forced to produce the same amount of heat regardless of conditions. The only explanation to be offered is in the following: Given a certain amount of braking, and consequently a certain amount of heat produced by friction, it would seem that this heat has several ways of expending itself. About one-half of it goes directly to the wheel, the balance to the shoe. The shoe being a much smaller body, is heated to a much higher temperature than the wheel, in some cases as high as 2,000°. This hot shoe expends its heat by conduction to the wheel, brake head and air, and by radiation to surrounding objects. Cast iron is a better internal conductor of heat than wrought iron, and consequently the temperature of the cast iron shoe tends to become uniform, whereas with the wrought iron shoe the temperature will vary rapidly from the surface next to the wheel to the back of the shoe. This causes the cast iron shoe to dispose of more of its heat by conduction to the air and brake head and by radiation to surrounding objects, so that it has less heat to impart to the wheel. The theory has also been advanced that the wrought iron shoe comes in close contact with the surface of wheel, while the cast iron shoe forms for itself a lubricant in the form of a fine iron dust which prevents, in a measure, the shoe from really touching the wheel. This theory has been illustrated in the experiments made. After a continued application of the wrought iron shoe, it has been found that its surface in contact with the wheel has undergone an abrading action, whereas the surface of the cast iron shoe was uniform, as if ground.

A perforated cast iron shoe was tried, consisting of two plates with core space between them and supporting ribs; from the bearing surface of the shoe to the core space a number of small holes extended, there being rows of these holes in the planes of the wheels. When these shoes were applied it was noticed that a fine iron dust escaped through these holes into the core space, and when the shoe was afterward examined it was found that in a line through these holes the metal had the appearance of the wrought iron shoes, but between the rows the metal was uniformly ground. If the above theory bears out this assumption, the wrought iron shoe, coming into a more intimate contact with the surface of the wheel, gives more of its heat to the latter and less to the air-brake head and surrounding objects.

An examination of a great many cracked wheels has conclusively shown that the usual cause of cracking is a fault of the wheel. This fault can be traced to the condition of the metal at the junction of the double plate, there being usually but one-quarter of the section of the plate of good metal to resist the strain due to heating; often there appears to be no good metal whatever; nothing but dirt and blow holes.

Judging the temperature of some of the wheels found cracked in coming down the grade, and from touching them with the hand very soon after they were cracked, it seems very probable that most of the wheels cracked at a temperature of about 225°

The cracking of wheels on the mountain grades could certainly be reduced by a removal of faulty and dirty iron at the junction of wheel plates. The dirt at this junction appears to be present for the following reasons: When the iron is poured into the mold it goes to the bottom and spreads to the rim, and finally fills the upper or outside plate. The metal which

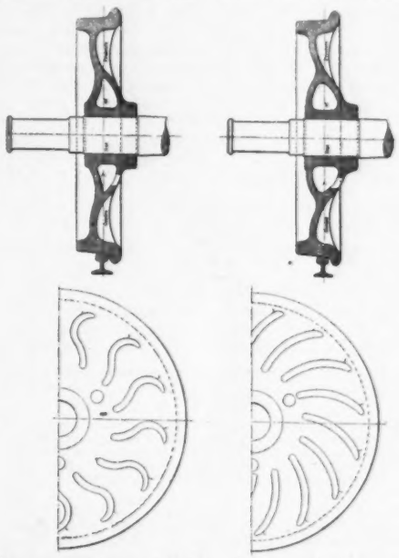


Fig. 3. Section and Half Elevation of JN Wheel Which Gave Best Results in Tests.

Fig. 4. Section and Half Elevation of Old Pattern Sacramento Wheel.

forms this plate is almost the first that enters the mold, and which has been cooled by contact with mold and chill. The metal which forms the lower plate, such as the ribs and the inside plate, comes in contact with surfaces already heated by the first metal passing over these surfaces; the consequence follows, that the outer plate is about the first part of the body of the wheel which solidifies; the metal in the ribs and the inner plate being in a still liquid state, arrests the dirt in an attempt to work out, and causes it to adhere to the metal forming the solid outside plate, and likewise affects the gases forming the blow holes in a similar manner.

The effect on a body-hung brake,* of the rising of the sides of a car when rounding a curve with brake applied, has often been discussed. It may be of interest to know that it does not bring any appreciable increase of strain on the brake hanger. With a pull on hanger balanced in the brake test machine, the brake shoe could be raised ½ in. with the hand without the least effort, the motion only being limited by the movement that could be imparted to the scale beam. If the shoe is traveling over the tread of the wheel at the rate of 40 ft. per second, it is difficult to admit that increasing the rate to 40½ ft. per second (as would be the case when a 6-in. per second upward motion of the shoe is added to the revolving motion of the wheel), should increase the pull or strain on the hanger to any considerable extent.

In explanation of the great variety in the length of the different tests of the foreign wheels: the signal for the engine to stop was given when a wheel was heard to crack, and it is remarkable that the cracking could not only be heard, usually, near the machine, but could often be noticed at a distance of 150 yds., regardless of considerable noise occasioned by the machine when in operation. See one instance: A wheel (WN), which was cracked in its first test, but without being detected, was subjected to a severer test, when, at the expiration of about 38 minutes, it was heard to crack very distinctly, but before the machine could be stopped it broke in two, about a third of the wheel flew out, and, choosing a downward direction, caused a slight damage to the machine.

Comparing the JN wheel and the old pattern Sacramento wheel, as to their relative merits in regard to their stability, it appears that the JN wheel possesses decided advantages for the following reasons. The pressure exerted on the journal is transferred to the wheel plates in radial directions parallel with the center line of pressure, running through point of contact between wheel and rail. A wheel subjected to vertical pressure alone should have the contour of its outside plate conform as much as possible to this center line of pressure, or, in other words, the straighter and nearer the outside plate is to this center line the better results can be expected, for the reason that the strains will largely be borne by the outside plate alone, as would be the case in the JN wheel (see Fig. 3), whereas, in the case of the old Sacramento pattern wheel (see Fig. 4), the outside plate deviates considerably from the center line of pressure, and consequently brings the greatest pressure to bear at the junction of both inside and outside plates. This defect, when taken in connection with the expansion and contraction of the metal at the junction of wheel plates, as previously referred to in this report, may be considered as one of the causes of the frequent cracking of wheel plates.

The results of these tests proving conclusively that the JN design of wheel is the best to resist effects of heating, patterns after this design were made, in-

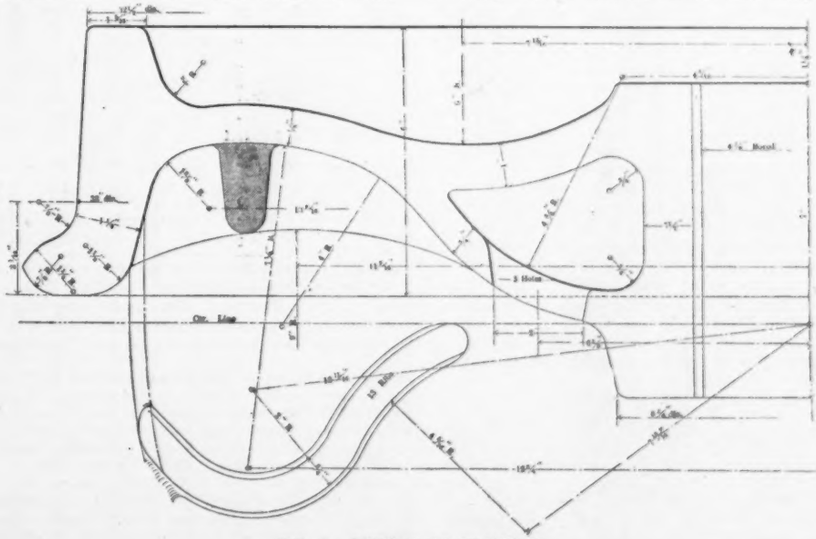


FIG. 5. DETAILS OF JN WHEEL.

creasing weight of wheel, however, to 690 lbs., distribution of metal being practically the same. (See Fig. 5.)

3,500 wheels from these patterns have since been made and placed in service under passenger cars, care being taken to get reports promptly of all wheels removed. Up to date but one JN wheel has been removed on account of "cracked plate," and a careful investigation of this wheel revealed the cause to be "dirty" iron in outside plate. An average of weekly tests of these wheels with M. C. B. drop test, is as follows: Cracked, 11th blow; broke, 20th blow.

* Refers to supposed tendency of body of car to raise trucks off rail through pull on brake hanger when brakes are applied.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXV.

(The subjoined article is published out of its turn before completion of the summary of distribution of time to various studies, in order to give time for the receipt of some corrected reports.)

It is a well known peculiarity of the profession of engineering that an unusual percentage of its followers are led through their training in it into other pursuits, usually of a more lucrative nature, as managers or superintendents of railways and other large public and private works, manufacturers, contractors, and what not. The fact is beyond dispute. It is a matter of every day observation. We have made an effort to determine from the records of the several colleges, when they had any, the extent to which this occurs.

Two causes have prevented entirely satisfactory results, however: 1. Comparatively few of the colleges seem to keep any accurate record of their graduates. Only 31 out of some 56 colleges have attempted to make any returns at all on this head, and a goodly proportion of these seem to be open to the suspicion of having been prepared from imperfect information. 2. There is discoverable both in the statements of engineers themselves and of college professors in regard to them a tendency to class a man as still in practice as an engineer when he retains merely the shadow of such title, or not even the shadow; but is really in business as a manufacturer or contractor or a manager of some public or private work.

Beyond doubt engineering knowledge and aptitude are largely brought into play in such callings. That is the reason that so many engineers go into them; and the man who is conscious that he is what he is because he is an engineer has a perfect right still to call himself one, and certain plausible grounds for claiming that he is practicing as such. But for our present purpose, which is to find out how many openings come to the engineer outside the strict line of his profession, the tendency is unfortunate. It undoubtedly has the effect to increase materially the apparent percentage of men who stick close to professional practice.

Yet even on its face the showing is a striking one. Table XXV. shows all the returns we have received on this head, covering the facts as to 3,542 graduates of engineering schools, all deceased graduates, all of unknown occupations and all graduates of the last two years being omitted; and it shows that in round numbers an even half of all graduates of more than 6 to 8 years' standing are now engaged in some other occupation. The colleges are arranged in order of age, as in all our other tables, and by running over the subtotals of the table it will be seen that in the oldest group only 47.8% of the graduates are now practicing as engineers; in the oldest college of that group, only 43.5%; in the next oldest group, 56.3%, and in the three youngest groups an average of about 75%. When allowance is made for some of the obvious errors in classification (as, for instance, Nos. 26, 27 and 41), where "Engineering practice" has evidently been given a very broad sense, the probable percentage of men who have gone out of such practice to better themselves is still further increased.

According to the face of the returns about 7% of all engineering graduates become railway officials and nearly as many more managers of works of various kinds. Only 2.1% confess themselves to be contractors, which, in our opinion, is much less than the real percentage. More than one-quarter of the whole are in "other" occupations, a great many of whom, perhaps as many as 10% of the whole number of graduates reported, are engaged in teaching engineering.

To see how nearly these figures of college graduates might compare with the status of our leading engineering society, we have had the curiosity to make a tally of the entire membership (full members only) of the American Society of Civil Engineers. The result is embodied in Table XXVI. We have not undertaken to make a similar tally of the Mechanical or Mining societies, but a mere cursory glance at their lists of members shows that an enormously greater proportion of them are following non-professional pursuits, more or less allied to engineering, but in no proper sense "engineering practice."

It is obvious that a tally of the full members of such a society as the Am. Soc. C. E. might be expected to show quite different results from a tally of college graduates only. The latter are mere youths, with no basis of experience to determine their choice of a profession. The former must have passed many years in the actual practice of their profession and attained a considerable standing therein to be admitted at all. They are, therefore, one would expect, far less likely to go astray from the path which they have so long followed with success.

Yet the statistics show that the percentage of men in and out of "engineering practice" properly so called, is almost precisely the same among the full members of the American Society of Civil Engineers as among the college graduates. In brief the two compare as follows:

Percentages.

	Eng'g. prac.	Ry. officers.	Man. works.	Contract- ing.	Other occ'ns.
3,542 college grads	58.9	7.0	6.6	2.1	25.4
1,110 M. Am. Soc. C. E.'s	56.2	7.8	4.5	2.4	29.1

In preparing the last line of this summary from Table XXVI. we have classed in "Pres. or V. P. of corporation" with "Railway officers," because most of them are in fact railway officers. Similarly, we have included "Manufacturers" with "Managers of Works" because we apprehend that this was done, as a rule, in the college returns. Similarly, we have added the whole of the "Not specified" members of the Am. Soc. C. E. to the total of "Other occupations," because we infer from our knowledge of the membership of the Am. Soc. C. E. that most of those members who are listed only by their address, without specifying any occupation or position are in fact either temporarily or permanently out of practice, and most of them permanently. If we infer that one-third to one-fourth of these "Not specified" are really still following engineering we shall have the following comparison for the two outer columns alone only, leaving the three intermediate columns the same.

Percentages of.	Eng. practice.	Other occup'ns.
3,542 college grads.	58.9	25.4
1,110 M. Am. Soc. C. E.'s	61.5 to 63.2	23.8 to 22.1

Undoubtedly this last summary more nearly corresponds to facts, but either one indicates that the two classes of men segregate into different occupations according to the same law, and the two together strongly indicate this to be the fact, and we believe it to be so: Men trained to engineering leave it for other occupations, not because they are frozen out of it and compelled to take up something else, to any large extent, but because they are tempted out of it by larger occupations for which their training fits them. Otherwise, no larger proportion of men trained to this profession would leave it than learn the medical, legal or theological professions; for there certainly is no larger percentage of poor engineers than there is of poor doctors or lawyers or ministers; there could not be and accomplish what they do.

The fact, therefore, seems to us to be established statistically, that engineering does open up a broader field for all kinds of varied talent, and to aid a man to find some niche suited to him which he can fill well, than any other large profession, and we deem this to be a not unimportant factor in considering whether or not it is wise for a young man to enter it.

It is very common for older men, even the most successful, to run down their own profession, from painful remembrance of the difficulty of finding "room higher up" in it, and that familiarity which breeds contempt with the mental and moral deficiencies of its average followers. Such dark side there must be to every profession, for as long as men in general feel (as all in their hearts do) that it is somewhat more of a distinction to be a successful professional man than to be in business or farming or in a trade, engineering and every other profession will tend to become crowded to the caturation point, and some of the weaker aspirants will be driven to the wall. But, speaking from a long and intimate acquaintance with all the ups and downs and ins and outs of the profession, we candidly believe that there is not to-day any profession upon which a fairly gifted youth with some taste for it can enter with so great approach to certainty of reasonable worldly success as engineering. More than any other profession, it offers immediate employment to young graduates at good salaries. More than any other profession, it offers a permanent competence to men who prove to have only mediocre abilities; there is no place anywhere for a

TABLE XXV.

Present Occupations of Engineering Graduates, so far as known; all deceased graduates, all of unknown occupation and all who have graduated since 1890 are omitted from this table. Some doubtful returns are in parenthesis and not included in the totals.

No. of college.	Engineer'g.	Ry. off.	Man. w'ks.	Contracting.	Other occasions.	Total listed.	Per ct. engrs
1	320	53	37	3	323	736	43.5
2	40	5	11	10	48	114	35.1
4	36	....	....	1	6	43	83.9
5	125	8	10	1	54	198	63.1
Totals	521	66	58	15	431	1,091	47.8
Per cent.	47.8	6.0	5.3	1.4	39.5	100.0	....
10	22	....	....	.	23	45	49.0
11	280	65	59	5	123	532	52.6
12	195	12	22	3	30	262	74.4
14	102	56	46	32	22	258	39.6
15	45	6	8	7	4	70	64.3
16	46	3	....	..	35	84	54.8
18	65	3	8	2	20	98	66.3
19	42	2	2	7	13	66	63.7
20	(20)	....	....	..	(136)	(156)	(12.8)
Totals	797	147	145	56	270	1,415	56.3
Per cent.	56.3	10.4	10.2	4.0	39.1	100.0	....
23	98	28	10	6	54	196	....
25	104	....	....	..	44	150	70.7
26	324	20	16	..	5	365	89.0
27	87	....	....	..	17	104	83.7
28	40	..	....	2	13	55	72.9
29	23	1	5	..	28	57	40.4
Totals	580	21	21	2	107	731	79.3
Per cent.	79.3	2.9	2.9	0.3	14.6	100.0	....
33	22	12	....	..	10	44	50.0
34	26	....	3	..	6	35	74.3
36	30	....	1	..	11	42	71.6
37	16	....	....	..	25	41	39.0
38	(102)	....	....	..	....	(102)	(100.0)
41	28	....	....	..	1	29	96.8
42	6	....	2	..	4	12	50.0
43	3	....	1	..	4	8	37.5
Totals	131	12	7	..	61	211	62.1
Per cent.	62.1	5.7	3.3	..	28.9	100.0	....
47	25	....	1	..	20	46	54.4
48	4	....	1	1	2	8	50 0
49	19	....	....	..	1	20	95.0
50	10	....	2	..	6	18	55.6
51	....	....	....	..	2	2	0.0
Totals	58	....	4	1	31	14	61.6
Per cent.	61.6	....	4.3	1.1	33.0	100.0	....
Grand totals.	2,087	246	235	74	900	3,542	58.9
Per cent.	58.9	7.0	6.6	2.1	25.4	100.0	....

TABLE XXVI.

Present Occupations or Positions of the Full Members of the American Society of Civil Engineers.

Practicing Engineers.	No.		P. c.
Consulting civil engineers	73		
Civil engineeers in private practice	99		
Mechanical and mining do	24	— 196	17.6
Railway chief engineers	97		
State and canal chief engineers	10		
City chief engineers	42		
Water-works chief engineers	18		
Superintendents motive power	5	— 172	15.5
Railway assistant engineers	74		
Canal and state assistant engineers	9		
City assistant engineers	34		
Water-works assistant engineers	14	— 131	11 8
Bridge building engineers	54	54	4.9
U. S. assistant engineers	38		
U. S. N. assistant engineers	8	— 46	4.1
U. S. A. corps of engineers	25	— 25	2.3
Total in strictly engineering practice		624	56.2
Not practicing as engineers, but in related pursuits.			
Railway officers	61		
Managers of works	33		
Pres. or V.-Pres. of corporations	26		
Manufacturers	17		
Contractors (not bridge)	27		
In business	27		
Professors of civil engineering	24		
Public officers	10		
Inspectors	4		
Editors of engineering journals	5	— 234	21.1
Not specified, mostly not practicing and engaged in some business		252	22.7
		1,110	100.3

half-skilled physician, but there are a great many excellent places as assistants for the half-skilled engineer, if only he is faithful and does what he can do well. More than any other profession, the field for its practice is expanding, almost limitlessly it sometimes seems, so that it cannot for some decades to come at least be as crowded relatively as other professions. More than any other profession it trains studious executive, inventive and commercial abilities at once, so that men who have to have either in high degree are peculiarly apt to have opportunities open to them to enter upon other and more lucrative occupations.

With all these good qualities, how can it be expected that the highest rewards in the strict line of the profession shall be as great as in some other professions? If they were so every one would enter engineering. It is because there is no real room for any but the highest skill in some other professions that their highest rewards are so great. No man wants any but the best skill his money can buy to cut off his leg or manage his lawsuits. If he tries to economize in that way circumstances soon compel him to realize his folly. But he is content with very ordinary skill to build him an ordinary bridge, or to survey a railway for him or drain his farm; and even if he has been a fool for his pains he is not apt to have that fact brought home to him with the sudden sharpness which it does when his lawyer makes a fool of himself in court, or poor doctoring costs him a child.

The consequence is that entering upon the profession of engineering is not so much of a gamble as with other professions. It may not have so many prizes—or at least not so many great ones—but it has far, far fewer blanks, and if account be taken of the prizes in allied pursuits to which he may aspire it is doubtful if any other profession offers so many prizes. Brilliant ability, combined with a sufficiently suave and deferential manner to inferiors, will speedily carry a man to the top of any profession. What the average young man wants, however, is a profession which, while not lacking in prizes for brilliant ability, offers blanks only for decided incompetence. This he gets in engineering. He gets it as fully in no other profession that we know of, though the profession for which the intelligent young man feels most attraction is generally the one he can enter with best chance of success.

That engineering offers a very wide field for all kinds of ability is proved in a way by the table last given, which we have seen represents fairly the average of the profession. The American Society of Civil Engineers, taken as a whole, represents the more successful fraction of the "Civil" branch of engineering (with many mechanical and mining engineers), though there are of course inferior men in it and superior men out of it. They are already summarized in one way in the table, from which it appears that 17.6% of its members (besides 5.4% bridge building engineers, or 23% in all) are in practice for themselves; 15.5% of them chief engineers, 11.8% assistant engineers, and so on through the list. Summarizing them in another way, in respect to the branches of engineering practice in which they are engaged, so far as indicated by the table, we have the following:

	No.	P. C.
Engaged in railway and bridge practice (which is chiefly railway) including railway officers.	317	61.6
State and canal work	19	3.7
City work	76	14.7
Water-works	32	6.2
U. S. service (chiefly hydraulic work)	71	13.8
Total of specified branches of engineering practice	515	100.0
Consulting engineers, managers of works, manufacturers, contractors, etc., and unspecified	593	

It is perhaps a fair assumption that the large unspecified total, if divided among the specified branches in proportion to their actual nearest alliance, would be divided about in the same proportion. If so, the overmastering importance of the railway branch of engineering is very evident from this table, especially if we remember that city work and U. S. Service, the two next largest subdivisions, are relatively very unattractive branches, by general admission. In view of this fact it would appear to an outside observer as if the amount of attention paid to railway specialties in the curriculums of most of our engineering schools was quite disproportionately small. The strictly professional instruction to be had at college, i. e., that part which the graduate will use directly in his future work to base his actions on, is small at best, almost nil. It stands to reason that the undergraduate who knows enough to know what he does want, wants to be most thoroughly grounded in matters appertaining to that branch of the profession which offers the greatest chance for employment and most professional plums. This he does not now get at any college that we know of.

THE RENSSELAER POLYTECHNIC INSTITUTE.

Sir: In the article on the Engineering Schools of the United States, published in your edition of September 22, you credit the Rensselaer Polytechnic Institute with but 7½ hours per week, in your table giving the number of hours per week devoted to instruction. This, on the face of it, is an error. I am unable to account for this error, as I can find no copy of the data relating to this subject, which were sent you some time ago. The total number of hours of instruction given is 2,849, of which 1,287 are devoted to recitations and lectures, and 1,022 to drawing, field and laboratory work. This gives an average of 20.3 hours per week, since the total number of days in the school year, after deducting vacations, is 175. Of the total time, 64.1% is devoted to lectures and recitations, 22.9% to drawing and laboratory work, and 13.0% to field work.

I take this opportunity to concur with you in your views, ably expressed on page 232, of your edition of Sept. 8, on the importance of confining the instruction in technical schools to general fundamental principles. The time allowed in any such school is not too great to ground well a student in the principles underlying all branches of engineering, and the attempt to make a specialist of a youth, who has had no general training by differentiating branches at an early period of the course—which, certainly, with most engineers cannot be differentiated in after experience—seems to me to be wrong in principle. Palmer C. Ricketts.

Troy, N. Y., Sept. 29, 1892.

LEHIGH UNIVERSITY.

Sir: In the article on "Engineering Schools of the United States," in Tables XXII. and XXIII., Sept. 22, you do not do justice to Lehigh in giving only 15.8 hours to the mechanical and civil courses. You cannot get the number of hours properly from the register, but will have to get it from Prof. Klein and Prof. Merriman, to have it accurate. G. H. F.

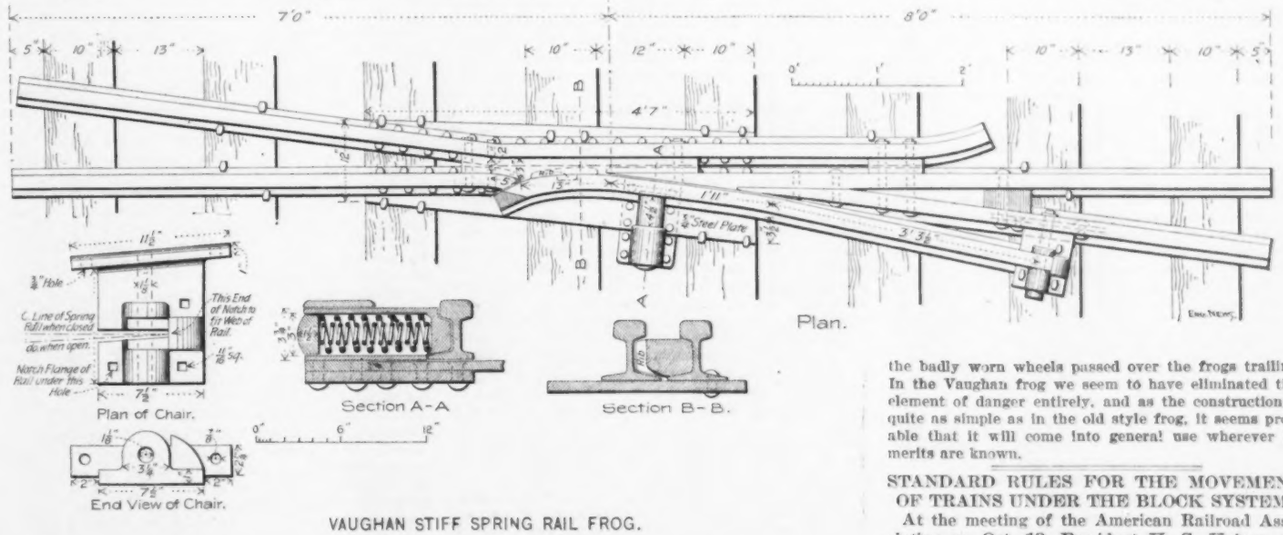
Bethlehem, Pa., Oct. 7, 1892.

(We assumed, of course, that the catalogue schedules were correct. If wrong, there is still time to embody a corrected schedule.—Ed.)

VAUGHAN STIFF SPRING RAIL FROG.

We illustrate this week a rather novel pattern of spring rail frog, in which the spring rail is pivoted at its outer end, and the spring is nearly opposite the frog point. The filling block at the throat is so arranged as to guide the wheel in case of accident to the spring rail, and has a rib which fits under the head of this rail. The frog is the invention of Mr. Vaughan, and was patented May 3, 1892. It is being put on the market by the Central Oil & Supply Co., of New York, and the company has recently received the following very favorable letter from Mr. M. W. Thomsen, Engineer of Maintenance of Way, Pennsylvania R. R.:

The Vaughan stiff-spring frog has proved in every way satisfactory on our road. For two or three years we had abandoned the use of spring frogs for the reason, mainly, that the spring rail was frequently pushed out when the badly worn wheels passed over the frogs trailing. In the Vaughan frog we seem to have eliminated this element of danger entirely, and as the construction is quite as simple as in the old style frog, it seems probable that it will come into general use wherever its merits are known.



VAUGHAN STIFF SPRING RAIL FROG.

STANDARD RULES FOR THE MOVEMENT OF TRAINS UNDER THE BLOCK SYSTEM.

At the meeting of the American Railroad Association on Oct. 12, President H. S. Haines addressed the members concerning the proposal to add to the Standard Code of Train Rules rules for the movement of trains by the block system. In opening he referred to the victory won by the Standard Code over all opposition, so that it is now adopted and in use on about 100,000 miles of railway. To-day it is referred to in the courts as embodying the best modern practice, and the railroad management that ignores it handicaps itself in any litigation involving the reasonableness of train rules or a failure on the part of employees to observe them.

The Association established a committee on amendments, to pass upon questions as to the interpretation of the code and suggestions as to its improvement. In considering proposals for amendment, however, the committee has rightly been conservative.

There is a large army of railroad employees and officials distributed over 170,000 miles of railway who should each of them be thoroughly versed in this code. They should be so familiar with its very language as to be capable of reciting it from memory. The rules will then readily recur to their minds in an emergency. It is for this reason that once the language of the code has been so fixed as to be incapable of misinterpretation it should not be changed except to conform to accepted improvements in train service, and then only after careful consideration.

Again, since the code should be applicable to

the train service of all roads operated under what may be called the American system and should contain all rules necessary to the movement of trains with safety, it follows, first, that only the primary rules, embodying principles which under no conditions can be disregarded with safety, can be accepted and followed by all; and, secondly, that to them should be added such secondary rules as are required for the movement of heavier traffic. The single-track roads of light traffic can then adopt the primary set of rules and when their traffic increases can add to these the secondary rules necessary for the safe movement of trains. That the Standard Code is defective in that it does not recognize improved methods of train service which have been to some extent in use for years on our best roads, and which are now deemed essential to the successful conduct of a heavy traffic, was Mr. Haines' contention. We reprint the remainder of his address, as follows:

From one end of the code to the other there is nothing to show that it is customary in this country to provide any other means for protection of trains against each other than the efforts of the trainmen themselves.

The "Train Rules," so called, are, by themselves, applicable only to the operation of a single track road with a light traffic. For any considerable business, even on a single track road, they would be supplemented by "The Rules Governing the Movement of Trains by Telegraphic Orders." But when we go on a step further and provide for an increase of traffic by the use of "running sidings" as distinguished from "passing sidings," we get no aid from the code as to the proper rules to be observed in using them. Neither are double track roads recognized except in approaching the end of double track, as in Rule No. 94, or in passing from double to single track, as in Rule No. 95.

The time has now come when the double track roads begin to call for recognition by the Train Rule Committee and to ask for a standard set of rules for the protection of their trains by methods which do not depend solely upon the intelligence or vigilance of train employees.

The idea of maintaining intervals of time between trains has been realized in various ways, as by track sentries or by the display of signals at curve or at other specially hazardous points or by a record at stations, visible from passing trains, showing the time that the last train had passed in the same direction. The method of time intervals between following trains affords efficient protection so long as the trains maintain a uniform schedule speed, can be readily stopped within the recognized time interval, and are not liable to unexpected delays between signal stations. These conditions prevail on roads doing principally a passenger business with light and frequent train, and such roads can be and are now successfully operated under this method.

A heavy freight traffic cannot be satisfactorily conducted under a time interval between trains. The liability to unexpected delays between signal stations is great and more time is required to stop the train than in passenger service, as also for flagmen to get back to the distance in which the following train can be stopped, due allowance being made for grades and curves. A proper regard for these different conditions compels an increase in the time interval, which seriously embarrasses the service, especially as the intervening passenger trains must respect the same interval, and the resulting tendency is to restrict this interval within too narrow limits.

A comparison of rear collision reports will show that the most of them are with freight trains. Experience therefore proves that a time interval does not afford sufficient protection on roads that have a heavy freight traffic unless that interval be so extended as to seriously interfere with business—yet this was the only method available until it became possible to establish an interval of space by means of the electric telegraph. This method of conveying information had been for some time used for other purposes before it became the accepted medium for orders to trains, but even now that the Standard Code includes "The rules governing the movement of trains by telegraphic orders," those rules are mainly a protection against butting collisions only. For protection against rear collisions it is not rules for moving trains that are required, but rules for stopping them. We want rules for stopping them by maintenance of a time interval for those who prefer that method and rules for stopping them by a space interval for those whose traffic has outgrown that method.

The maintenance of space intervals is no novelty, for it has been for years in use upon many of our roads. The appreciation of its value has become so prevalent that its more general adoption is demanded, not only by the railroad journals, but also in the daily newspapers. Why, then, does not our Train Rule Committee add to the Standard Code "Rules for the movement of trains under the block system?"

The railroad corporations elected under our rules as the members of this committee select from among their own officials those whom they deem best fitted to represent them in this connection; the committee has at its command the resources of our extensive membership from which to obtain any information required for the purposes for which it was constituted; this special subject has been before that committee for over a year, and yet not even a preliminary report has been made. I do not propose to arraign these gentlemen before you to-day but, being ex-officio a member of their committee, to offer without their knowledge an explanation in their behalf. They recognize the necessity for greater uniformity in the operation of trains under the block system; they acknowledge that the Standard Code should include a set of rules applicable to this system; they respect the call made upon them by the Association to furnish such a set of rules, and would gladly respond to the call, and yet they fail to do so. Being rather a looker-on than an active participant in their deliberations, I have not only observed their situation, I have reflected upon it. My conclusion is that their inaction, if I may so term it, is due neither to their inability nor to their indisposition to codify the ordinary practice in the use of the block system, but because they are in doubt as to the sufficiency of that ordinary practice to provide for the normal increase of train service on the roads where these rules are more anxiously desired, and because of the impending changes in the conditions under which the service is to be performed.

To make clear to you what I have in mind, I will outline briefly what these conditions have been, keeping in view the object to be attained, the maintenance of a distance interval between following trains. The change of this interval from one of time to one of space was first secured through the aid of the electric telegraph, and the information thus obtained was transmitted by signal from the receiving operator to the engineer of the approaching train. This information was of a simple character, either that there was or was not a train in the space intervening between himself and the receiving operator. This was the fundamental principle of the "block" system, that the engineer of a train approaching a signal station was to be informed from that station whether there was or was not a train in the block ahead of him.

The next step was to instruct that engineer as to the use he was to make of that information. There was no doubt as to the rule which he was to follow when the block was clear—he was to proceed. But what was he to do when he was informed that the preceding train was still in the block? Was he to go ahead or not? The safest rule was to stop until the block was cleared. But just as increasing traffic became embarrassed by the time interval, so the same experience followed the institution of the space interval, and this embarrassment it was sought to remove by such a modification of the rule to stop until the block was cleared as permitted the following train to enter the block with the knowledge that it was not clear.

This is the broad distinction between the absolute and the permissive block system. The former is not only safe, but simple; the latter requires that the rear of the first train in a block must be protected by flagmen, with due regard to the relative speed of the two trains, to the curves and gradients of the track, and to the distance in which the following train could be stopped. I think, therefore, that it is fair to say that the permissive block system is an improvement on the time interval only in this respect: that the engineer of the approaching train can be informed whether there is or is not a train in the block ahead.

I say that he can be informed, but it is possible that he may not be informed, and, as a matter of fact, sometimes he is misinformed. This brings us to consider the manner in which this information is conveyed from the receiving operator to the approaching engineer. The latter must receive it through the eye or ear, by visible or by audible signals. If through the eye, the impression received, must either be as to form, color or position. This opens a field of discussion as to how the visible signals shall be made. If by form, whether a ball, a banner or a semaphore arm; if by color, what colors shall be employed, and what shall they respectively signify; if by position of several objects, what shall be their relative positions, and what shall they signify.

At this point it may be well to observe that whatever differences of opinion there may be among experts as to the adoption of the absolute or the permissive block system, they ought to make an effort to reconcile their differences so far as to unite in recommending a uniform system of signals for conveying information to the engineer of an approaching train. The causes for their different opinions are all well founded, but they are not irreconcilable. It is true that they have become more involved of late through the introduction of interlocking switch plants, as I will mention later in my remarks; but what I wish to impress upon you is that, in the operation of the block system, a code of rules for the guidance of train men is one thing and a code of signals for conveying information to them is another, and that neither should be confounded with the appliances for operating these signals. For the better understanding of my views as to the duty of the Train Rule Committee in this matter I will repeat that there are three separate subjects connected with the operation of trains under the block system:

First. The rules for the guidance of train men.

Secondly. The signals which are to convey information to them.

Thirdly. The appliances for operating the signals.

The mention of the third subject brings up a matter which, by the rules of our Association, has been specially committed to the standing Committee on Safety Appliances, to consider and report upon all questions affecting the essential requisites of devices for interlocking switches and for block systems ;the other two subjects being properly within the purview of the standing Committee on Train Rules. As the three subjects are somewhat interdependent, your Executive Committee has rquested that the two committees shall jointly consider them.

The necessity for this joint action is due to the bearing which the character of the appliances may have upon the character of the rules and signals, and here comes in another element to intensify the difficulties which our committees have had to encounter.

The appliances for operating the signals are controlled directly by the operator at the entrance of the block, who manipulates them in accordance with the information which he has received from the operator at the outlet of the block. The information that the block is clear or not clear is conveyed to the engineer of the approaching train through human agency, and the possibility of error is doubled, or rather tripled, by the intervention of two persons besides the engineer. He may either misinterpret or disregard the visible signals; the receiving operator may misinterpret or disregard the information which is to control the display of the signals; the sending operator may either transmit that information incorrectly or fail to send it at all.

Leaving out the rules for the guidance of trainmen and the code of signals, the block system, so far as it is in general use, is deficient in providing the means for the protection of following trains because it does not eliminate the element of human fallibility. This defect railroad managers, signal manufacturers and inventors are trying to remedy, and it is because our Train Rule Committee is conscious of these facts that it has hesitated to indorse the block system as now used. Their hesitation has been increased by the contest btween the several systems which have been devised to supplement the present system,and which are now in experimental use to an extent which promises to simplify the solution of the problem by an exclusion of that which has failed in trial. The effort to eliminate human agency begins with the normal state of the signal, whether the action of the operator at that point shall be required to inform the approaching engineer that the block is clear or that it is not. If he can only give this information under the control of the operator at the outlet of the block, there is one mind less to make a mistake. It is for the Train Rule Committee to so determine the normal state of the signal as to reduce the probability of its being misinterpreted or disregarded by the approaching engineer, and for the Safety Appliance Committee to determine the essential requisites of the appliances which shall prevent the receiving operator from displaying a signal improperly.

Going to the other end of the block, we have to guard against the transmission of incorrect information to the receiving operator or the failure to send it at all. The latter contingency may be avoided if the normal state of the entrance signal can be changed only by the act of the sending operator, but the former, the protection against the transmission of incorrect information, is more difficult to secure. This man has to determine that the block is or is not clear, and then control accordingly the display of the signal at the other end of the block. He determines that the block is clear, first, from a notification that a train has entered, next by actual observation of its passage. It is not sufficient for him to know that an engine has passed out of the block, but also that every car which was attached to that engine when it entered the block passed out with it. That some such protection should be required by the rules is within the province of the Train Rule Committee, as it is the province of the Safety Appliance Committee to determine the essential requisities of the appliances by which that protection shall be secured.

Admitting that the operator at the outlet of the block is correctly informed that the block is clear, we have next to insure that his information is correctly transmitted to the entrance and the signal properly displayed. The respective duties of our two committees in this matter are also obvious.

If the rules, signals and appliances for the use of the block system can be successfully wrought out to this stage then there is yet another step to be taken, which shall eliminate the intervention of the sending operator. This has been experimentally accomplished by several devices actuated by the train, as it passes the entrance

and outlet of the block, simultaneously operating a display of signals required to block the interval which it is entering and to clear that which it is leaving; indeed, this effect can now be extended to the next block behind it, so that the engineer of a following train is thereby informed, not only as to the condition of the block ahead of him, but also as to the condition of the block ahead of that.

This extended protection is required, since the speed and momentum of trains having exceeded our ability to stop them within the distance in which, under all circumstances, the signal at the entrance of the block can be made visible to the approaching engineer. To meet this difficulty, and to avoid the consequently necessary retardation of the train, the entrance or home signal has been supplemented by the distant signal, and, in the system above described, the entrance signal of one block is the distant signal of the block next ahead. The circumstances under which distant signals should be required will affect the rules for operating a block system as well as the essential requisites for the proper appliances.

Here we seem to have reached the ultimate limit of the resources at present available for the protection of trains against each other, outside of the efforts of the trainmen themselves. There is another step which may yet be taken, that of protecting the trains against the misconduct or neglect of these very trainmen, by the introduction of appliances connected with the block signals which shall strike the engine gong or blow the whistle or apply the brakes, or even close the throttle-valve of the approaching train, but these appliances have not reached such a stage of efficiency as to call for further notice in this connection.

Proceeding on a line parallel with the improvement of the block system, there has been a demand for greater security against derailment or collisions from misplaced drawbridges or switches or at railroad crossings. This demand has led to the introduction of appliances for controlling one or more such points from one location. For convenience of operation, this control has been gradually brought into accord with the control of the block system signals and, as a measure of safety, that accord has been made interdependent by the introduction of interlocking plants that have developed into marvelously ingenious pieces of mechanism. In this development there have been involved the same questions as to rules, as to signals and as to transmitting information to train men and to operators that have followed upon the development of the block system and, as a consequence, there has come about a complication which our Train Rule Committee can not disregard. It is the confusion that may arise as to whether a signal is intended to show the position of a switch or that the block ahead is clear or occupied. On a few of our trunk lines a still further complication has arisen which will extend with increasing traffic. This is occasioned by the construction of additional running tracks so that the train rules and signals are required to provide for running trains on more than two tracks. While this is not a pressing want just now, it may well be provided for in a code of standard rules for a block system in order to insure consistency with that code in the further development of such service.

The intervention of mechanical appliances in the movement and control of signals, switches, drawbridges and crossings and the interlocking of such appliances have induced the substitution of other motive power for the muscular power of man, and to-day we employ steam, compressed air and electricity for this purpose, either singly or in combination. To what extent this substitution should affect the standard block system rules or the appliances required by those rules are matters that even our Standing Committees may not pass judgment upon without the aid of those who are expert in the application of such forces to our purposes.

I will not refer at greater length to the task now before our joint committee on Train Rules and Safety Appliances, and hope that what I have said in explanation of the difficulties which they have encountered will be sufficient to justify their tardiness and in some measure to indicate the course which they must pursue.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Evidence of Authority for Survey.

A paper purporting to be a testimonial, taken from the protocol of an order or survey made more than a century ago by the officer who executed and was custodian of the protocol, coming from proper custody and free from suspicion, is admissible in evidence without proof of its execution. But where a survey is made without legal authority, copies of the field notes thereof, though certified from the general land office, are inadmissible. Von Rosenberg v. Haynes, Sup. C. of Texas. 20 S. W. Rep., 143.

Must Yield to Demands of Actual Survey.

Courses and distances must yield to the demands of an actual survey when the evidence determines the fact of such survey, so that, where the surveyor's field notes show actual surveys on the ground, and the lines and corners thereof are called for as contiguous, and evidence of such surveys are still found which reasonably indicate an excess in the distance of the lines of 200 varas in 7,116 varas, at the date of the survey (1856), considered trifling, and a slight variance of 75 varas in the course, these discrepancies should not overcome the other evidence pointing to the fact that the surveys are contiguous. Graham v. Dewees, Sup. C. of Texas. 20 S. W. Rep, 127

The American Road Improvement Co. has been incorporated at Albany, N. Y., for the construction of permanent and substantial roads. The company has acquired property to enable it to take contracts for road building and to supply material and road machinery. It is the owner of extensive blue limestone quarries at South Bethlehem, N. Y., and it is expected to establish the works for the manufacture of road machinery at Hoosick Falls. President, J. Russell Parson, Hoosick Falls; Vice-President, Legrand C. Tibbitts, Hoosick; Secretary and Treasurer, F. A. Sawyer, Portland, Me.; General Manager, P. Callihan, South Bethlehem. The office will be at Albany, N. Y.

A very high bridge is proposed over the Ruhr River, on the Solingen-Remscheid Railway, in Germany. As planned this bridge would be 1,640 ft. long and the piers would be 338 ft. high. The contract is let to the Gustavsburg Bridge Works, of Mayence, at $500,000. It is to be completed in two years. Instead of being the "highest bridge in the world," as claimed by the "Zeitschrift fuer Transpertwesen und Strassenbau," it is exceeded in height above the water by the St. Guistoria, Tyrol, 460 ft.; the Garabit viaduct, 406 ft., and the proposed Du Viaur viaduct of 382 ft. It exceeds the height of the Loa viaduct, in Bolivia, by 2 ft. only.

Water-works are being built for the Oliver Chilled Plow Works, at South Bend, Ind. According to the South Bend "Tribune," the supply will be pumped from a well 22 ft. in diameter and 30 ft. or more deep. A 1,560,000-gallon Worthington duplex pump will be used, and about 1½ miles of mains and 20 hydrants will be put in.

The street grades of Great Falls, Mont., having been fixed by City Engineer Worley, objection was made by some of the influential citizens, as is usual in such cases. The city councils then adopted the sensible plan of calling in a commission made up of Mr. Andrew Rinker, City Engineer of Minneapolis; Mr. F. W. Blackford, City Engineer of Butte, Mont., and G. W. Struck, City Engineer of Spokane. These experts, after careful examinations, and with some minor changes proposed, approved of the plans of Engineer Worley, and all parties are satisfied. The chief point to be made is, that in a new and growing city, where few improvements are yet made, this plan is a most wise one, and is the only plan which is likely to insure the least future trouble. The benefits far outweigh the extra cost.

The premature explosion of a blank cartridge in a 6-in. gun of the warship "Philadelphia," at the recent sham fight at Baltimore, has been officially reported upon. In the first place the breech mechanism was not at fault. The explosion was due to lack of sponging after each discharge, except by the marine sponge, and to an unusual amount of deposit left in the chamber by the previous unconfined charge." The accident also points to several necessary changes in the position of the ammunition scuttles, which are now directly in the rear of the gun, with the chutes leading directly to the magazine passage. It is also proposed to adopt metallic cartridges for the 6-in. gun, as is now done in some foreign navies. This would be expensive, but almost essential to safe rapid fire in actual warfare.

A cave-in occurred in the Hog Run tunnel on the Louisville & Nashville R. R., near Worthville, Ky., Oct. 5, and several men who were at work relining the tunnel were injured.

A Boston sanitary commission is proposed, made up of three persons skilled in sanitary and medical science, to be appointed by the Mayor. This commission would take into consideration all matters pertaining to the health of Boston, Mass., with special reference to the introduction and spread of cholera, with full power to carry out any recommendations they may deem necessary for the health of the city. The expenses of this commission would be charged to the appropriation for the Board of Health.

Another "whaleback" ship has been launched at West Superior. This is the "Colgate," 320 ft. long, 38 ft. beam and 25 ft. in depth. In regard to the "Wetmore," lately shipwrecked on the Oregon Coast, the builders say that she reduced the cost of carrying coal from Puget Sound to San Francisco, from $2.75 to $1.50 per ton, and the Southern Pacific Railway Co. had fitted up a dock to unload her 2,490 tons in three days, instead of the three weeks formerly required for other ships. The whaleback promoters still have unbounded faith in these vessels, and the company is planning a transatlantic ship of this type.

A large blast by which 5,000 cu. yds. of rock were dislocated was recently fired on the line of the Everett & Monte Christo R. R., now under construction in Washington. The point on the line where the blast was fired is about five miles from Monte Christo, near the "summit" or divide which parts the waters of the Sauk and Stillaguamish Rivers. At this point the road skirts a rocky promontory several hundred feet above the level of the river, the survey line running along a kind of natural bench for a considerable distance to a point where it is abruptly broken by a sharp projecting side of the mountain. Through the projecting "nose" it was necessary to make a deep cut in order to reach the beach on the opposite side. To do this it was decided to be cheaper to blast away the whole "nose." This was done by driving a tunnel from each side about 50 ft. long with pockets at their ends, which were filled with dynamite and giant powder. The blast was entirely successful, driving a clean cut about 150 ft. long, and dislocating a body of rock about 70 ft. high and 40 ft. thick. It will require considerable more blasting to entirely remove the debris. The blast was fired by the contractors, P. H. Smith & Co.

A considerable plant of automatic electro-pneumatic block signals, embodying the latest improvements, is to be erected by the Union Switch & Signal Co., on the line of the Pennsylvania R. R., between New York & Philadelphia. This replaces the ordinary manual block system which has been in use there for many years.

The East River Bridge Co. has filed a petition with the New York Board of Aldermen for permission to construct the elevated approaches of its two proposed bridges across the East River. This company was chartered in March, 1892, to construct two bridges across the East River: one running from Broadway Brooklyn, to a point between Delancey and Rivington Sts., New York, and the other, from a point between the pier line and Fulton St., Brooklyn, to a point between Jackson and Scammel Sts., New York. According to the published plans, the bridges are to be of the suspension type, with four steel cables holding in suspension four trusses carrying two railway tracks, two driveways and one promenade. The width of each bridge will be 76 ft. Each will be 135 ft. above water at the center, and 120 ft. at the pier lines. The piers will be of masonry from the foundations to a point above the roadways, and of steel towers above these points. Their dimensions at the water line will be 145 ft. × 60 ft. The anchorages will be of masonry, 130 ft. × 110 ft. It will be remembered that this is the company which the Union Elevated Ry. Co., of Brooklyn, N. Y., is backing, and that the objects of the proposed bridges are to connect the New York and Brooklyn elevated roads. Its officers are: Pres., Frederick Uhlman; Vice-Pres., Jacob Ruppert; Secy., Elisha Dyer, Jr.; Treas., Geo. W. Wingate, and Ch. Engr., Geo. B. Cornell.

The steel bridge across the Missouri River at Omaha, Neb., which the Omaha Bridge & Terminal Co., proposes building, will, according to the newspapers, contain a swing span 520 ft. long, or about 17 ft. longer than that of the New London, Conn., swing, at present the longest swing span in the world. It is stated that work will soon begin upon the false works for the bridge at once. The bridge will carry a double-track steam railway, a motor railway and a wagon road.

Incandescent lamps are to be used for street lighting at Geneva, Switzerland. A rather peculiar contract has been made by the city with the electric lighting company. The lamps and current are furnished at the following rates:

Size of lamp.....	16 c. p.	10 c. p.	8 c. p.
Rates, cts. per hr.....	1	0.8	0.6

The electric lighting company's dynamos are driven by turbines, taking water from the city's water supply. All the water must be taken from this source, and is to be paid for at the rate of 0.4 ct. per cu. m. (1½ cts. per 1,000 gallons). The minimum quantity taken must not be less than 400,000 cu. m. per annum. If the company earns more than 6% on its capital invested, it must pay one-third the excess over that amount to the city.

New dock accommodation for Atlantic steamers is to be provided by the Docks Committee, at Bristol, England. The Town Council has adopted the report of the Docks Committee recommending the building of new docks, together with a landing stage, deep water pier and other accommodations, at Avonmouth, 7 miles below the city, at the mouth of the river Aven, upon which the city is situated. The estimated cost is $5,000,000. With this accommodation, the port of Bristol will, it is contended, offer exceptional advantages for the Atlantic mail and passenger traffic.

Another fine steamboat for the Fall River Line, planned to eclipse even the "Puritan," "Pilgrim" and "Plymouth," is to be built at once, by the Delaware River Iron Ship Building & Engine Co. (the old John Roach yards). The machinery will be furnished by the W. & A. Fletcher Co., of New York City.

An important court decision sustaining the Interstate Commerce Law and the acts of the Commission working under it was delivered by the U. S. Circuit Court for

the Southern District of New York, on Oct. 5. The case was the Interstate Commerce Commission vs. the Texas Pacific Ry. Co. The Commission appealed to the Court for the enforcement of its order requiring the railway to cease carrying imported goods on through bills of lading at less than the established inland tariff rate. The railway admitted that it had not obeyed the order, but pleaded that its acts were not contrary to the law, and also that the proceeding was defective because the Southern Pacific Co., which does the same thing, was not made a part defendant.

The Court in its opinion says that the defendant cannot escape upon the plea that another wrongdoer is also violating the law, and grants the order restraining the railway from further violation of the Commission's order. We quote the conclusion as follows:

The Interstate Commerce Act would be emasculated in its remedial efficiency, if not practically nullified, if a carrier can justify a discrimination in rates merely upon the ground that unless it is given the traffic obtained by giving it, would go to a competing carrier. A shipper having a choice between competing carriers would only have to refuse to send his goods by the one of them unless given exceptional rates to justify that one in making the discrimination in his favor on the ground of the necessity of the situation.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

CLEVELAND BELT.—The date for opening the 7-mile belt line at Cleveland, O., is placed at Nov. 1. The two bridges across the Cuyahoga River are now the only causes of delay.

NEW YORK CENTRAL & HUDSON RIVER.—This company is reported to have under consideration the construction of a belt line from Syracuse to Dewitt or East Syracuse, N. Y., a distance of about five miles.

MICHIGAN CENTRAL.—This company has petitioned the Town Council of South Haven, Mich., for right of way from its present terminal to the river where it intends to erect elevators and run a line of steamers from South Haven to Milwaukee, Wis.

LITTLE FALLS & DOLGEVILLE.—Work is now progressing so favorably on this railway from Little Falls to Dolgeville, N. Y., 11 miles, that it is expected that it will be open for traffic by Oct. 15. The grading is completed, and only three miles more of track remain to be laid. The bridge work which has been delaying tracklaying, is now nearly completed.

CHICAGO, MILWAUKEE & ST. PAUL.—The extension of this road to Houghton, Mich., noted last week, will be about 50 miles long and will have the present line at Port, Mich., about ten miles north of Sidnaw. Later reports state that the contracts have not been, as noted last week, but that they probably will be in the spring.

SANDUSKY & COLUMBUS SHORT LINE.—The fine weather is facilitating work on this line, and, with no bad luck, it is expected that the road will be completed this year. At the present rate of progress all the track will be laid by Nov. 1. Fifteen days of good weather will see the grading of the entire line practically completed. About 40 miles of track has been laid up to date, in addition to the 33 miles first built from Sandusky to Bellevue. Track has been laid from Bellevue south to Attica, on the Baltimore & Ohio R. R., and also from Marion north to the county line, and south to Waldo. At the latter place a track has been laid to a gravel pit, and ballasting will begin at once on that section of the road. The track from Columbus will be laid as far as Worthington in a few days. About 58 miles of track are already laid.

TOLEDO & OHIO CENTRAL.—A meeting of the stockholders was recently held to take action on several propositions in regard to an increase of capital, etc. The propositions, unanimously approved, were as follows: To increase the capital stock of the company from $4,849,000 to $6,500,000; to extend the line from the present terminus at Columbus to Ridgeway, Hardin Co., Ohio, to purchase that part of the Toledo, Columbus & Cincinnati Ry. lying between Toledo and Ridgeway, and to issue bonds of the company in the sum of $2,500,000 for the purpose of extending the road and making other improvements.

AU SABLE & NORTHWESTERN.—It is reported that men are being out at work on an extension of this road toward Twin Lakes, Mich., about 35 miles.

LACKAWANNA, LAKE ERIE & HONESDALE.—Chartered in Pennsylvania to build a railway from Honesdale to Moscow, Pa. Pres., Hon. W. H. Dimick, Honesdale, Pa.

Projects and Surveys.

ATLANTIC OCEAN RY. CO.—This company has been chartered in New Jersey to build a railway four miles long along the branch at Atlantic City, N. J. Among the incorporators are: Chas. C. Cutler, Wm. Fowden and James R. Clark, of Camden, N. J.

TROY & NEW ENGLAND.—The latest details in regard to this proposed railway from Troy, N. Y., east to the state line, are given as follows, by the "Troy (N. Y.) "Times": "At a meeting of the Troy & New England R. R. directors was held Oct. 1, but no business of importance was transacted other than the perfecting of arrangements with the New York Construction Co. for building and equipping the road. The prospects for the rapid building of the road are excellent. The franchise obtained from the Common Council expired by limitation Sept. 30, but it is thought there will be no difficulty in having it renewed, now that there is definite promise of the completion of the road. Secretary J. J. Tillinghast, of the company, said a committee would be sent to New York to continue negotiations with Mr. Raymond, of the construction company, which has made an offer to build the road. A communication received at the meeting from Mr. Raymond, stated that the original surveys of the road were feasible. Subscriptions will not be asked for until arrangements for the construction of the road assume definite shape. The Common Council will be asked to renew the company's franchise."

UTICA & UNADILLA VALLEY.—Work is reported begun on this line from Bridgewater to New Berlin, N. Y., 20 miles.

RHODE ISLAND & WESTERN.—Work is being rapidly pushed on the survey between Providence, R. I., and Danielsville, Conn. Two parties are now at work, and it is expected that the survey will be completed in four weeks.

SOUTHERN CENTRAL.—It is said to be altogether likely that this proposed line from Sunbury, Pa. to a connection with the Philadelphia & Reading R. R., near Harrisburg, Pa. It is intended to begin the grading this fall and to push the work so as to complete the line during next summer.

KISHACOQUILLAS VALLEY.—This company has received bids for the construction of its line from Reedsville to Belleville, Pa., 9½ miles. Pres., Sam. Watts, Belleville, Pa. Ch. Engr., F. F. Whitlekin, Lionesta, Pa.

Southern.—Existing Roads.

OXFORD & COAST LINE.—Work is being pushed on the 4.5-mile line from Oxford, N. C., to the Durham & Northern R. R. It is expected to be completed in 60 days.

LOUISVILLE, ST. LOUIS & TEXAS.—The surveys have been completed for the proposed extension from West Point, Ky., into Louisville, Ky., and it is reported that the contracts for grading have been let. This company now uses the tracks of the Newport News & Mississippi Valley Co., between West Point and Louisville, and the object of the extension is to secure an independent line.

CHARLESTON, SUMTER & NORTHERN.—The branch from Bennettville, S. C., to Gibson's station, 11¼ miles, is now completed with the exception of the ballasting.

CHESAPEAKE & OHIO.—The contract to build four miles of the Loup Creek branch has been let to Gooch & Rinehart, of Staunton, Va. The branch will be 12 miles long.

ATLANTIC COAST LINE.—The surveys for an extension from Winston to Wadesborough, N. C., which have been in progress for some time, are now well on toward completion. The line will be about 92 miles long with maximum grades of 70 ft. per mile, and maximum curves of 6°. Ch. Engr., Flemming Gardner, Wilmington, N. C.

Projects and Surveys.

ATLANTA ELEVATED.—This company has been organized to build an elevated railway, traversing the southern portion of the city, and connecting the Georgia R. R. with the Central R. R. of Georgia. The road will be used for the transfer of all freight and passenger cars between the two roads. The officers of the company are: Pres., Rufus B. Bullock; Treas., E. M. Blalock; Cons. Engr., E. L. Corthell; Ch. Engr., H. T. McDaniel, and Secy., Frank J. Hoyle.

ASHEVILLE.—The "Manufacturers' Record" says: "The committee in charge of the movement for additional railroads out of Asheville, N. C., has received a proposition from parties represented by Breckenridge Cabell, of New York City, to build the projected road from Asheville to the Tennessee state line. The parties are to be given a charter, and the counties along the route are to vote $200,000 in bonds. A. M. Turner and others, of Rutherford Co., are interested in the proposed railroad from Asheville to Rutherfordton. Nott Atkinson, of Asheville, N. C., can give particulars."

CHERRY RUN & POTOMAC VALLEY.—The engineers of this company under the direction of C. M. K. Watts, are now locating its proposed line from Cherry Run, Md., to Harper's Ferry, W. Va. The line was surveyed some time ago, but it is expected that the route can be considerably shortened, making its total length about 32 miles.

ABBEVILLE SOUTHERN.—Chartered in Alabama, to build a railway from Abbeville, Ala., to some point on the Alabama Midland R. R.

Northwest.—Existing Roads.

CHICAGO & NORTHWESTERN.—The company has made a proposition to build an extension from Ponca to New Castle, Neb., 14 miles, on condition that the citizens of the latter place give free right of way and 40 acres of ground for station and yard purposes.

CHICAGO, MILWAUKEE & ST. PAUL.—This company has purchased right of way from Appleton to De Pere, Wis., and will build a railway to connect with the various mills at Kimberly, Kaukauna, Wrightstown, Little Kaukauna and De Pere.

PEORIA BELT.—Work is reported begun on the extension of the belt railway at Peoria, Ill.

CHICAGO, ROCK ISLAND & PACIFIC.—The latest rumor in regard to this company is that it proposes to extend its line to Denver, Colo. It is stated that the new line will start from Goodland, Kan., and reach Denver by the way of Abbott, Arapahoe Co., Kan.

Projects and Surveys.

SIOUX FALLS WESTERN.—At a recent meeting of this company it was decided to make a new survey between Sioux Falls and Madison, and Sioux Falls and Yankton, S. Dak.

Southwest.—Existing Roads.

MORGAN'S LOUISIANA & TEXAS.—It is rumored that this company will build a branch from Eola, La., to Marksville, La.

GREENFIELD & NORTHERN.—Grading has been completed on the extension from Aurora to Mt. Vernon, Mo., 11.5 miles. It is now stated that the road will be extended to Osceola, Mo. Gen. Man., T. A. Miller, Greenfield, Mo.

SOUTHERN PACIFIC.—Tracklaying has been completed on the line from Bakersfield, Cal., to Asphalto, 49.9 miles, and the line is now being ballasted.

MISSOURI, KANSAS & TEXAS.—The grading on the extension from Boggy Tank to Sealy, Tex., is nearly completed, and tracklaying has been begun. It is intended to have the line in operation by Nov. 1.

Projects and Surveys.

CARTHAGE, GALENA & SOUTHEASTERN.—Engineers are now at work on the surveys for this proposed railway from Carthage, Mo., to the Arkansas line. Willard E. Winner, of Kansas City, Mo., is interested.

NATCHEZ, ALEXANDRIA & TEXAS.—The engineering party which started the preliminary survey for this line at Alexandria, La., a few weeks ago, is making rapid progress in the work.

ALVIN & DICKINSON.—The organization of a company to build a railway from Alvin to Dickinson, Tex., is contemplated.

MEMPHIS, HOT SPRINGS & PACIFIC.—Chartered in Arkansas to build a railroad from Little Rock, Ark., southwest through Sabine and Garland counties to Hot Springs. Among the incorporators are D. C. Rugg, Hot Springs, Ark.; W. A. Compton, Little Rock, Ark., and B. E. Orr, of New York City.

Rocky Mt. and Pacific.—Existing Roads.

ASTORIA & PORTLAND.—All work has been suspended on this railway from Astoria, Ore., south toward Hillsboro, Ore., on account of inability of the contractors to secure pay for their work.

SAN FRANCISCO BELT.—The contract for the proposed extension of this line has been let to Healy, Tibbitts & Co.

COOS BAY, ROSEBURG & EASTERN.—The majority of the stock of this Oregon company has been secured by John D. Spreckels & Co., of San Francisco, Cal., who, it is stated, will complete the road. The road was completed from Marshfield, Ore., to Dunham's, 10 miles, and the line further graded to Coquille City, 10 miles. It is announced that the purchasers will ultimately completes the road to Coquille City, and that in the spring it will be extended to Myrtle Point and Roseburg. Secy., W. E. Baines, Marshfield, Ore.

Projects and Surveys.

CANYON CITY & CRIPPLE CREEK.—Surveys are now in progress for this proposed line from Canyon City to Cripple Creek, Colo., noted in our issue of Sept. 15. Ch. Engr., H. A. Sumner, Denver, Colo.

BUTTE, ANACONDA & PACIFIC.—New articles of the incorporation of this company have been filed with the Secretary of the State of Montana. Like the old ones, they provide for a railway from Butte City, Mont., to Anaconda, Mont., and thence up Warm Springs Creek to Granite and Philippsburg and thence over the range to the Bitter Root Valley at a point near Hamilton. The surveys for the portion of the railway from Butte to Anaconda were completed some time ago, and everything is practically ready for the grading. It is probable that contracts will be let soon. The officers of the company are: Pres., W. L. Hodge; Secy., F. C. Cruger, and Treas., Wm. M. Thornton.

ELKHORN & OLD BALDY.—Chartered in Montana to build a railway from the Elkhorn mill in Jefferson Co., to the base of Old Baldy Mt. Among the incorporators are: Geo. H. Hill, E. W. Knight, Jr., and Wm. R. Logan.

ELECTRIC RAILWAYS.

SANFORD, ME.—The Mousam River Ry. will soon be under construction. The power plant will consist of four dynamos, driven by a 150-HP. turbine, made by the Humphrey Machine Co., Keene, N. H. A masonry dam has been built to form the reservoir which will supply the water power. The old passenger station at Portland has been purchased for a carshed, and will be removed in sections. It is 80 ft. long, 40 ft. wide, and has a slate roof. The route has been surveyed by Mr. Cummings, of Portland, and the rails and ties have been purchased.

NEW YORK, N. Y.—A storage battery car of the Acme Storage Battery Co. has been tried on the Ninth Ave. street railway.

LEWISTON, N. Y.—The Lewiston & Niagara Falls Electric Ry. Co. has commenced grading, but stopped by trouble over the right of way. The project includes the erection of a tall observatory tower at the falls, and the extension of the line from Lewiston to Youngstown. Pres., John M. Brinker, Buffalo, N. Y.

BUFFALO, N. Y.—The Buffalo Ry. Co. has been granted permission to substitute electric for horse power throughout the city.

SCRANTON, PA.—A Philadelphia syndicate, which includes Edward E. Denniston, John P. Bevy, Stephen B. Haas, C. Ford Stevens, and James Richardson, Jr., is said to have arranged for the purchase of all the electric lines of the People's Street Ry. Co. Steps have been taken to secure a charter as the Scranton Traction Co.

POTTSTOWN, PA.—The Pottstown Street Ry. Co. and the Citizens' Street Ry. Co. have applied for power to build electric railways. James Hellig, of Reading; John S. Weber and John P. Dunn, of Pottstown, are interested.

DAYTON, O.—The Third St. Ry. Co. has decided to accept electric traction, and has already purchased the power plant.

SANDUSKY, O.—An electric railway is to be built to Huron and Milan, and possibly extended to Norwalk.

CHICAGO, ILL.—The Chicago City Ry. Co. has awarded to the Westinghouse Electric & Mfg Co., of Pittsburg, Pa., a contract for the equipment of 61 cars with single reduction motors, and for four 200-HP. generators for the crosstown lines, which are now operated by horses.

SAN FRANCISCO, CAL.—The Twenty-third Ave. Electric Ry. Co. has been incorporated; capital stock, $300,000; Wm. J. Landers and H. W. Meek.

PORT ARTHUR, MAN.—The Town Council proposes to submit a by-law to raise $40,000 for the extension of the electric railway to West Fort William.

ELEVATED AND CABLE RAILWAYS.

ATLANTA, GA.—The Atlanta Elevated Ry. Co. has been organized to build an elevated railway and union station. Pres., Rufus B. Bullock; Secy., F. J. Boyle; Chf. Engr., H. T. McDaniel; Cons. Engr., E. L. Corthell.

CINCINNATI, O.—The Consolidated Street Ry. Co. proposes to build a cable inclined plane up Price Hill, with a platform large enough to accommodate an electric and trail car each trip.

CHICAGO, ILL.—The Chicago & South Side Elevated Ry. Co. proposes to make an additional issue of $3,000,000 first mortgage bonds.

HORSE RAILWAYS.

ELIZABETH, N. J.—Elizabeth & Plainfield Street Ry. Co.; $100,000, all paid up; J. B. McGiffert and W. H. Peddle, of Roselle; J. H. Vail and L. M. Whitaker, of Westfield.

MCKEESPORT, PA.—Reynoldton & Port Vue Traction Co.; $18,000, $3,600 paid up; Pres., Horace Crosby, Pittsburg.

HIGHWAYS.

NEW YORK.—Justice Dykman, of White Plains, in his charge to the Grand Jury at the Circuit Court, called attention to the condition of the roads in Westchester Co., and particularly that between White Plains and Port Chester. From the town line to Port Chester the road is nicely macadamized, but from the line to White Plains it is deep sand. He wanted the Grand Jury to see whether the Highway Commissioners were liable to indictment, and, in any event, to make a presentment to the court.

NEW JERSEY.—The Board of Freeholders of Middlesex Co., at New Brunswick, has awarded the contract for work on the Madison township road to J. F. Shanley, at $12,250. Mr. Fountain is Chairman of the Road Committee.

WASHINGTON.—Peter Costello has been awarded the contract to build the wagon road from Kasio City to the mines, a distance of 28 miles. The contract will amount to $50,000.

WATER-WORKS.

New England.

CAMBRIDGE, MASS.—A new reservoir will probably be built at a cost of $45,000 or more.

Middle.

ALBANY, N. Y.—The Water Board has voted in favor of the meter system.

ALTAMONT, N. Y.—The contract for works with a supply from a spring, said to be three miles distant, has been awarded to Ayrault & Co., Tonawanda, for about $14,000. There will be 18 hydrants.

CARTHAGE, N. Y.—The contract for works has been signed by Moffett, Hodgkins & Clarke, 16 William St., New York, for $46,500. Hinds & Bond, Watertown, bid $48,993, and J. E. McIntyre, Buffalo, $54,000. There will be two duplex power pumps with a capacity of about 1,000,000 gallons each; two 54-in. turbines; a 20 × 75-ft. stand-pipe; 4½ miles of 12 to 4-in. mains, and 50 double hydrants. Construction must be started before Oct. 10 and finished by May 1, next.

SARANAC LAKE, N. Y.—Bonds to the amount of $30,000 have been voted for water-works, and $7,000 for sewers.

SYRACUSE, N. Y.—Bids for $500,000 3½%, 25-year bonds for the completion of the new works, ranged from 101.44 to 102.77, for small lots. The Albany Savings Bank bid 102 for the whole issue.

KEARNEY, N. J.—J. H. Fullager, Dr. J. A. Exton, and Edward Kenny, have been appointed to act with members of the Township Committee in securing a new water supply. Water is now bought from Jersey City. Jesse Carver is President of the Township Committee.

WEST ORANGE, N. J.—It is reported that the Township Committee has passed an ordinance contracting with the Montclair Water Co. for water for 15 years. There will be 11 miles of mains and at least 110 hydrants. The works must be completed by July 1, 1892, and in partial operation on May 1.

ALLEGHENY AND PITTSBURG, PA.—Projects for supplying these cities continue to be discussed, but nothing definite has been done toward a joint supply. Engr. J. R. Harlow, Pittsburg, is reported as having a scheme by which water would be brought from the Monongahela River from a point many miles distant, and sold to these two and other cities for $25 per 1,000,000 gallons.

ALLENTOWN, PA.—The Water Commissioners have recommended the purchase of Schantz's Spring, about 4½ miles from the present pumping station. Cy. Engr. Gressart has submitted estimates for reservoirs ranging from $44,000 to $95,000, with $42,500 extra if the reservoir estimated to cost $95,000 be covered with brick arches.

EVERETT, PA.—The Everett Crystal Water Co. has been incorporated; $5,000; Treas., P. L. Williams.

HUNTINGDON, PA.—Permission to lay pipes in the borough has been granted to a second company. Chf. Burgess, J. C. Blair.

MORRISVILLE, PA.—The people have voted 160 to 59 for works.

PITTSBURG, PA.—It is reported that the Monongahela Water Co. has decided to lay a 12-in. main from a tank in addition to a 10 and an 8-in. main now in use.

WASHINGTON, PA.—It is reported that the company is considering the building of a new reservoir.

CUMBERLAND, MD.—Steps are being taken to appropriate $5,000 for surveys for new works under the direction of the Water Commissioners.

Southern.

WHEELING, W. VA.—The contract for a new pumping station to be built by the Holly Mfg. Co., Lockport, N. Y., has been signed. It is said that the improvements must be completed by Oct. 1, 1893, and that the total cost will be about $275,000.

ATHENS, GA.—Bids will be received until Oct. 24 for building works, including two 1,500,000-gallon compound duplex condensing engines, four 50-HP. return tubular boilers; 20 × 75 ft. stand-pipe on 75-ft. tower; 2,200 tons 6 to 18-in. cast iron pipe and specials; 130 post hydrants; 20-in. intake; buildings, intake well, clear water basin, and improvements to existing ponds and grounds. J. H. Rucker, A. L. Hull, C. M. Strahn, Commissioners; J. W. Barnett, Cy. Engr.

PIEDMONT, ALA.—It is reported that the Piedmont Electric & Water Supply Co. has recently been incorporated by Perry & Harris, who hold franchises, and that works will be built at once, including a 100,000-gallon reservoir. G. D. Harris, Pres.; R. S. Perry, Secy. and Treas.; Wm. Waring, Supt.

HUNTINGDON, PA.—A committee has been appointed to visit works in adjoining places with a view of finally building works here.

North Central.

ATHENS, O.—The people will vote on works.

ELYRIA, O.—It is reported that the city is thinking of buying the company's works.

GLENDALE, O.—Bids are wanted until Oct. 17 for furnishing and setting pumping machinery and boilers, and until Oct. 22 for a standpipe or elevated tank. Chas. B. Going, Secy. Trustees, United Bank Building, Cincinnati.

SALINEVILLE, O.—Contracts for $40,000 works have been let, it is reported.

NILES, MICH.—A special committee of the Common Council has estimated the cost of city works at $80,000. This includes two 1,500,000 pumps, a 12 × 100 or 125-ft. standpipe, eight miles 12 to 4-in. mains and 100 hydrants, with a supply from wells near a river. Works were built by a company in 1879.

CARBONDALE, ILL.—The "Free Press" advocates the formation of a new company to build works.

MORTON, ILL.—Bids for a small system are wanted as stated in our advertising columns.

PANA, ILL.—The Pana Water & Power Co. has been incorporated; $100,000; J. R. Edwards, I. L. Bullingame and others.

PRINCETON, ILL.—The Rock Rapids Water Co. has been incorporated; $40,000; W. G. Reeve, H. H. Ferris, Douglas Mosely. Works were built by the town in 1889-90.

Northwestern.

SHENANDOAH, IA.—W. C. Burton informs us that this town of 3,000 people is contemplating works to include driven wells, a stand-pipe, two miles out of mains. Estimated cost, $20,000.

WILLIAMSBURG, IA.—Fairbanks, Morse & Co. have the contract for works. There will be a tank.

STERLING, KAN.—Improvements are talked of. Address Dr. J. W. McCracken.

HARVARD, NEB.—The people may vote on works in November.

CHEYENNE, WYO.—It is reported that H. D. & T. McKay Booge, Sioux City, Ia., have secured a contract for $20,000 improvements to the works here.

Southwestern.

COLUMBIA, MO.—Plans and surveys for works are being made.

ST. LOUIS, MO.—Bids will be received until Oct. 18 for hauling, trenching and laying 2,500 ft. 36-in., 130 ft. 12-in. and 30 ft. 6-in. pipe. Geo. Burnett, Pres. Bd. Pub. Impvts.; E. S. Foster, Secy.

CORPUS CHRISTI, TEX.—Jaeger & McMullen will build the works by contract at once. The pumping station will be 15 miles from the city, it is said, on the Nueces River. There will be a stand-pipe. The city pays $90,000 toward the works, and a company $55,000. The company will operate the works until the money advanced is refunded from the revenues. It is reported.

EL PASO, TEX.—A move for a second plant, to be owned by a company or the city, has been under way for some time. John C. Regan, Omaha, Neb., and Dan. G. Kirschbaum, Denver, Colo., now decline a franchise.

TEMPLE, TEX.—The company has floated bonds and will improve its works.

COLORADO SPRINGS, COLO.—A special committee has been appointed to report on a new reservoir and a new 12, 14 or 16-in. main from the same. Irving Howbert, the City Engineer and Water-Works Superintendent are on the committee.

NORTH DENVER, COLO.—A franchise has been granted the Beaver Brook Water Co. by the Town Board, subject to the ratification of the people, Nov. 8.

Pacific.

COLTON, WASH.—Bonds to the amount of $10,000 have been voted for water-works purposes.

ELMA, WASH.—It is reported that works will be built at a cost of $9,000.

OAKLAND, ORE.—The Council has voted for works to cost about $12,000.

LOS ANGELES, CAL.—The City Council has received and adopted a report from its special committee on water-works recommending that bonds for city works be voted on, the works to be in accordance with plans of Cy. Engr. J. H. Dockweiler and approved by Engrs. Geo. Hansen, E. T. Wright, Aug. Mayer and F. W. Wood.

ONTARIO, CAL.—The Sierra Water & Power Co. has elected the following officers: Pres., G. A. Haskell, Los Angeles; Secy., J. W. Oakley, Ontario; Treas., F. S. Wallace, Pasadena. The company was recently incorporated with a capital of $200,000 to supply electric power, water for domestic and irrigation uses to Ontario, Rialto, Chino, Etiwanda and Cucamonga.

SANTA ROSA, CAL.—Plans and specifications for city works may be prepared by C. Monjeau, Cincinnati.

PRESCOTT, ARIZ.—Engr. Alex. O. Brodie, as member of a committee appointed at a citizen's meeting to report on increasing the water supply, recommends that a reservoir be built to impound the flood waters of Banning and Granite Creeks.

TUCSON, ARIZ.—Separate 50-year franchises for water and sewer systems are wanted by the Tucson Water-Works & Sewerage Co. The Tucson Water Co. built works in 1881 under a 25-year franchise.

IRRIGATION.

NEW COMPANIES.—Montrose Canal & Reservoir Co., Denver, Colo.; $100,000; Directors, J. C. Montgomery, C. C. Dorsey and others; to purchase and enlarge Uncompahgre irrigation canal and to operate in Delta and Montrose Cos. McClelland Underground Supply Irrigation Co., Greeley, Colo.; $24,000; Directors, Wm. McClellan, John Burchell and others; to operate in Weld Co. on lands of Wm. McClellan by means of the underground system of tiling.

SEWERS.

WESTBORO, ME.—The City Engineer has been directed by the City Council to prepare plans for a complete system of sewerage.

WALTHAM, MASS.—The Board of Aldermen has appropriated $15,000 for sewer extension.

PROVIDENCE, R. I.—The City Treasurer has been authorized to hire money amounting to $1,500,000 for the completion of the improved sewerage system as designed by Samuel M. Gray, and in conformity with the precipitation plan. The Common Council has ordered the construction of sewers in about a dozen streets.

BUFFALO, N. Y.—The Board of Public Works will receive bids until Oct. 19 for 10 to 18-in. tile, and 30 to 36-in. brick sewers.

LANSINGBURG, N. Y.—The Board of Water Commissioners will receive bids until Oct. 17 for a 12-in. vitrified pipe sewer.

SARANAC LAKE, N. Y.—At a recent special election the citizens voted to issue bonds for $7,000 for a sewerage system.

TROY, N. Y.—The Council has adopted resolutions for sewers in 12 streets, including two brick sewers.

ORANGE, N. J.—The contract for the building of the pumping station has been awarded to Reynolds, Conway & Co., and for the machinery to H. B. Merrill, New York, at $13,000 and $5,945, respectively.

PATERSON, N. J.—The Board of Public Works has voted to construct sewers in eight streets, including 2,700 ft. of 24 to 36-in. brick sewers.

WASHINGTON, D. C.—The estimates of Capt. J. L. Lusk for next year's work includes $1,063,814 for sewers, of which $573,500 is for main intercepting sewers.

CHATTANOOGA, TENN.—It is reported that the Board of Public Works is about to advertise for several short sewers to cost about $9,000.

FINDLAY, O.—Bonds will soon be issued for $60,000 for the construction of sewers in district No. 2.

SOUTH BROOKLYN, O.—The Village Clerk will receive bids until Oct. 31 for a pipe sewer and appurtenances on both sides of Pearl St., from Mill St. to Big Creek, a distance of 1,650 ft.

TIFFIN, O.—The lowest bid for the sewer in district No. 17 was that of John E. King, $42,155.

FORT WAYNE, IND.—Bids are asked until Oct. 25 for 2.3 miles of 4 to 6-ft. double ring brick sewer. F. M. V. Randall, Cy. Engr.

UNION CITY, IND.—The City Clerk will receive bids until Oct. 24 for the Clifford Ave. sewer.

ISHPEMING, MICH.—We are informed by Melville S. Hawkins, Supt. Sewer Dept., that the remaining two districts of the sewer system will probably be built next year.

ELMHURST, ILL.—It is reported that contracts are about to be awarded for a system to cost $75,000.

SIOUX CITY, IA.—We are informed by T. H. Johnson, Cy. Engr., that plans for two main stormwater sewers have been prepared for some time, and aggregate, with branches, about ten miles of sewers, ranging in size from 10 ins. to 7 ft. The delay in construction has been caused by the inability of the Council to decide upon a method of paying for the work. Heretofore storm sewers have been paid for in the same way as sanitary sewers, by adjacent property owners, but the Council is now trying to devise a more equitable plan. There is now under consideration an ordinance dividing the city into storm water districts, the districts conforming to the area drained by a sewer and its branches; bonds to be issued, and a tax levied upon all property in the district, based upon its assessed valuation, to create a sinking fund, to pay off bonds at maturity. There are objections to this, however, and nothing will be done until these questions are settled, and then, probably, about $100,000 will be expended in storm sewers. The city has about 35 miles of sewers, sanitary and storm water, in operation, and has just finished about a mile of 8 and 10-in. pipe sewers, including an inverted siphon under a small stream.

KANSAS CITY, MO.—The Board of Public Works has approved an ordinance appropriating $30,000 to complete the O. K. Creek sewer a distance of 853 ft. southwest from its present terminus.

DENISON, TEX.—The City Clerk will receive bids until Oct. 20 for 9,049 ft. of 18-in. salt-glazed, vitrified pipe sewer, to extend from the present outlet of the city sewerage system to the Red River.

DENVER, COLO.—The Board of Health has recommended that the City Council grant a franchise to the Western Sewage Co. This company is composed of local and eastern capitalists, and proposes to dispose of all the city garbage and sewage, without charge to the city, by piping it six miles from the city and using it to irrigate and fertilize a large tract of land.

BERKELEY, CAL.—The contract for the main sewer in South Berkeley has been awarded to the Pacific Construction Co., San Francisco, at about $15,000.

OAKLAND, CAL.—Two contracts have been awarded to Edward Cavanaugh and L. Kehoe at $17,413.

REDLANDS, CAL.—The lowest bidders for three contracts were Hughes & Meyer, their bids aggregating about $20,000.

CORVALLIS, ORE.—It is reported that plans are being prepared for a sewerage system to cost $50,000, and other street improvements to cost $10,000.

TORONTO, ONT.—W. J. Smith, architect, has written to the Mayor outlining a scheme for expending $1,000,000 in establishing a system of city drainage.

STREETS.

PROVIDENCE, R. I.—The Council has authorized the paving of Tockwotton St., from East St. to South Main St., with granite blocks; estimate, $11,000.

BUFFALO, N. Y.—The Board of Public Works will receive bids until Oct. 22 for 14 contracts for paving with Trinidad Lake asphalt, German Rock asphalt, Medina block stone, and brick.

NEW UTRECHT, KINGS CO., N. Y.—Several months ago the town proposed to open, grade and construct about 35 new streets. A public meeting was held Oct. 10 to discuss the proposed opening and grading of several streets.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Oct. 24 for seven contracts for flagging and curbing, including three for grading.

SYRACUSE, N. Y.—The contract for paving East Washington St. with first class sandstone, block pavement, on six inches of concrete, has been awarded to J. M. Mack & Co., at $118,000. The City Engineer's estimate was $140,000. The Council has voted to advertise for bids for paving three streets with brick or asphalt.

TROY, N. Y.—The City Engineer has prepared specifications for 21,170 sq. yds. of paving with granite block, including 10,700 sq. yds. in Congress St.

YONKERS, N. Y.—The City Clerk will receive bids until Oct. 24 for Paving Warburton Ave.

AMBLER, PA.—The Town Council has decided to macadamize Lindenwold Ave. a distance of 1,500 ft.

PITTSBURG, PA.—The Councils have voted to pave and grade 13 streets.

WASHINGTON, D. C.—The Engineering Department's estimates for the next fiscal year includes $730,000 for street work.

AUGUSTA, GA.—The City Council has ordered an additional block on Broad St. paved with asphalt. The total amount expended and voted this year for paving this street with asphalt aggregates $141,597.

KNOXVILLE, TENN.—It is reported that the city will lay about 30,000 sq. yds. of paving this fall.

DAYTON, O.—The City Engineer has been directed to prepare plans and specifications for paving 11 streets.

NORWOOD, O.—The Council will receive bids until Oct. 17 and 31, for grading, macadamizing, etc., one street at each date.

CANTON, ILL.—We are informed by W. G. Harte, Cy. Engr., that the bids for paving have been rejected, and that the work will be readvertised, and the contract awarded by the first Tuesday in November. The work includes 9,000 sq. yds. of paving with two layers of brick, 300 cu. yds. stone retaining wall, 860 lin. ft. curb, 860 lin. ft. brick sidewalks, etc., and is to be completed by Jan. 1, 1893. More paving may be added to the above in the spring, and several thousand feet of permanent sidewalks will doubtless be advertised this fall.

FREMONT, NEB.—The contract for brick paving and cement curbing in three new districts has been awarded to McDonald & Penfield, who also have the contracts for the sewerage construction and extension of the water mains.

GALVESTON, TEX.—The Board of Public Works will receive bids until Oct. 22 for curbing in 11 streets.

DENVER, COLO.—The Board of Public Works will receive bids until Nov. 1 for paving with Trinidad sheet asphalt.

LEWISTON, ORE.—Bids will be issued for street improvements. Surveys and estimates will be made at once, and the work completed by next spring.

ELECTRICAL.

NEWPORT, R. I.—The City Council received four bids for lighting the city by electricity for one or three years, the prices ranging from 35 to 67 cts. per light per night. Bids were also received for gas and naphtha lamps at prices less than under present contracts. The contracts have not yet been awarded.

ROCKVILLE, CONN.—The citizens have voted to construct a municipal plant to cost $25,000.

CHARLOTTE, N. Y.—The Board of Trustees will receive bids until Oct. 15 for 20 lights of 2,000 c. p. each. J. M. Allen, Village Clk.

RADFORD, VA.—An exclusive franchise for an electric light and power plant has been awarded to Mount & Jones.

COLUMBIA, S. C.—It is reported that an engineer is to be appointed to prepare estimates of the cost of a municipal plant.

MONTGOMERY, ALA.—The Council has awarded a five years' contract for city lighting to the Mutual Light & Power Co., at the following prices, each light to burn every night: 50 lights, 2,000 c. p., $108 per light per year; 150 lights, 1,200 c. p., $87 per light per year; 150 incandescents, $9.60 per light per year. The Council was influenced in awarding the contract by the scale of prices presented by the company to private consumers for incandescent light, which was as follows: 6 to 10 lights, $1.25 or $1 per month for all night or half night lights, respectively, and 20 to 40 lights, $1 or 90 cts. The Mutual Light & Power Co. was recently organized with W. F. Vandiver as President, and intends to erect a new and extensive plant; capital stock, $100,000.

SHELBYVILLE, KY.—The practicability of a plant is being considered by a special committee composed of L. C. Willis, W. A. McGrath and M. J. McCluskey.

LAWRENCE, KAN.—The City Clerk will receive bids until Nov. 7 for electric lights and gas for lights and fuel for both public and private use.

OGDEN, UTAH.—The City Council adopted a resolution Oct. 3 to advertise for 15 days for bids for street lighting.

BERKELEY, CAL.—The Berkeley Electric Light, Power & Heat Co., capital stock, $50,000, has been incorporated by A. A. Osborn, W. E. Sell and others. Mr. Osborn now has the contract for lighting the town, and it is proposed to increase the capacity of the present plant.

SEATTLE, WASH.—The only bid received for lighting the city for six months was that of the Union Electric Co., as follows: 16 c. p. incandescent lamps, $2.80 or $2 each per month for 6 or 12 mos. respectively; 50 c. p. lamps, $4.00 or $3.30; 2,000 c. p. arc lamps, $14 or $11.

NEW COMPANIES.—Hummelstown Electric Light Co., Hummelstown, Pa.; $10,000; Treas., John M. Murray. General Incandescent Arc light Co., New York, N. Y.; $250,000; Sigmund Bergmann, W. H. Meadowcraft, P. A. Klein. Citizens Light & Power Co., Rochester, N. Y.; $150,000.

CONTRACT PRICES.

SEWERS.—Philadelphia, Pa.—We are informed by J. H. Windrim, Dir. Pub. Works, that the contracts for the sewer in Passyunk Ave., and Shunk St. have been awarded as follows: James Deehan, three contracts, 13-ft. sewer, $28 and $29 per lin. ft.; 11 ft. 9 in., and 9 ft., $17; total, $130,000; Kennedy & McCafferty, one contract, 13-ft., $23.70; 11 ft., 9-in., $20.70; total, $35,000.

Lawrence, Kan.—The following contracts have been awarded to the Lawrence Plumbing & Heat Co.: 2,060 ft. lateral sewers, 7 ft. cut, 40 cts. per lin. ft.; 1,300 ft. 5 to 7 ft. cut, 39 cts.; 640 ft., 9 ft. cut, 45 cts.; 165 ft. of 8-in. pipe, 7.5 cut, 43 cts.; 165 ft. of 10-in. pipe, 9 ft. cut, 50 cts. This company bid 65 cts. per lin. ft. for 1,300 ft. of lateral sewer, 10 to 13 ft. cut, and 75 cts. for 640 ft., 16 ft. cut, but the contracts were not awarded.

Colfax, Wash.—We are informed by W. J. Roberts, Cy. Engr., that the following contract has been awarded to J. A. Clark, Spokane, at $7.25: 4,822 lin. ft. of sewer, average depth, 9.5 ft., including 12 manholes, 7 lampholes, 2 flushtanks, and 80 ft. of wrought iron kalamein pipe at river crossing (now dry). The 4,500 ft. of 12-in. sewer pipe and 150 Y branches are laid down to the contractor at $2.487, or 35% discount from list price. The contractor is to pay $4.50 per bbl. for cement, $2 per yd. for sand, and $7.50 per M. for brick.

STREET WORK.—Troy, N. Y.—The contract for paving three streets with brick has been awarded to James Malone at the following prices: John Porter patent protection brick, $2.46 per sq. yd.; new curb, 80 cts. per lin. ft.; new bridging, 80 cts. per sq. ft.; old curb, and bridging, reset, 8 to 11 cts. per lin. ft.; total, $52,902.

Salt Lake City, Utah.—The Board of Public Works has awarded the contract for paving Main and First and Second South Sts. to the Culmer-Jennings Paving Co., at the following prices: Sandstone curb, 11,000 lin. ft., 79 cts. per lin. ft.; paving with sandstone blocks, 15,000 sq. yds., $3.12 per sq. yd.; paving with refined asphaltum, 29,000 sq. yds., $2.79 per sq. yd. The lowest bid received at a previous opening for this work was published in our issue of Sept. 15.

PIPE.—Jackson, Mich.—The contract for 1,000 tons of water pipe has been awarded to the National Foundry & Pipe Works, Scottdale, Pa., at $22.10 per ton.

SHIP CHANNEL.—Mobile, Ala.—The contract for completing the channel of Mobile Bay, has been awarded to the National Dredging Co., Wilmington, Del., at 7.7 cts. per cu. yd. The bids were published in our issue of last week.

STONE.—Philadelphia, Pa.—Maj. C. W. Raymond has awarded the contract for furnishing and depositing stone in the gap at Delaware Breakwater to the Brandywine Granite Co., Wilmington, Del., at $3.20 per ton; total, $22,499.

ROCK AND BRUSH.—Rock Island, Ill.—Maj. A. Mackenzie has opened bids for furnishing riprap rock and brush, and recommended ten bids for acceptance, at the following prices: Furnishing rip-rap rock, 53 to 78 cts. per cu. yd.; brush, 28 to 35½ cts. per cu. yd.

REPAIRING WATERWAY.—Philadelphia, Pa.—The contract for repairing the waterway of Darby Creek has been awarded to Samuel Bastian, at 28 cts. per cu. yd. for embankment, and $1.40 per sq. yd. for riprapping; total, $14,300.

HUDSON RIVER IMPROVEMENTS.—Albany, N. Y.—Lt.-Col. G. L. Gillespie has opened the following bids for the work of deepening the Hudson River channel between Coxsackie and the state dam, at Troy. Edwards, Howlett & Thompson, New York, piling and round timber, 10⅞ cts. per lin. ft.; square timber, $36.75 per M.; manufactured iron, 3¾ cts. per lb.; paving stone, $1.07 per cu. yd.; dredging, 20.7 cts. per cu. yd.; removing rock, $6.37 per cu. yd. Ross & Sanford, New York, piling, 16½ cts.; round timber, 14½ cts.; square timber, $40; manufactured iron, 4½ cts.; paving stone, $1.60; dredging, 33 2-5 cts.; removing rock, $5. Wm. Fuller & Son, Albany, piling, 14 cts.; round timber, 10 cts.; square timber, $42; manufactured iron, 6 cts.; paving stone, $1.40. The total amount of the first bid on the entire work is a little below the engineer's estimate of $2,500,000, and the second bid is $474,0.0 higher.

DREDGING, ETC.—Portland, Me.—Lt.-Col. Peter C. Hains has opened bids for the following harbor and river improvements: (1), Improving Narragangus River; (2), harbor at Belfast; (3), harbor at Camden; (4), Bagaduce River; (5), Harrascecket River; (6), Kennebec River, rip-rap, Beef Rock Shoal; (7), Kennebec River, rip-rap, Upper Sand Bar; (8), Kennebec River, dredging, Upper Sand Bar; (9), improving channel in Back Cove; (10), harbor of Refuge, at Little Harbor, N. H. The bids were per cu. yd., except (6) and (7), which were per ton, and, unless otherwise specified, given in cts., and were as follows:

C. H. Souther, Boston, Mass., (3), 41; (8), 45; (9), 31½; (10), 27¾.

Metropolitan Dredging Co., Lynn, Mass.: (1), 27½; (2), 26; (3), 29; (5), 35; (8), 35; (9), 34; (10), 30.

Moore & Wright, Portland: (1), 30; (2), 24; (3), 29; (4), $10; (5), 29; (8), 31; (9), 27; (10), 26.

Thos. Symonds, Leominster, Mass.: (4), $6; (10), 30.

A. B. Martin, Boston, Mass.: (5), 34; (9), 32; (10), 27½.

National Dredging Co., Wilmington, Del.: (1), 29½; (2), 24½; (3), 30; (9), 33; (10), 28.

Robert Hamilton, Chebeague, Me.: (1), 33; (2), 28; (3), 28; (5), 31.

Jordan & Carleton, Bath, Me.: (6), $1.15; (7), $1.27.

George Newell, Richmond, Me.: (6), $1.24.

S. D. Houmelittes, South Dresden, Me.: (6), $1.24.

Chas. F. Wade, Richmond, Me.: (6), $1.10.

J. F. Hamilton, Portland, Me.: (6), $1.09; (7), $1.30.

MISCELLANEOUS.

RETAINING WALL.—New York, N. Y.—The Department of Public Works will receive bids until Oct. 19 for the construction of a retaining wall and appurtenances on the westerly line of the Riverside Park, between 119th and 129th Sts. The work includes about 2,200 cu. yds. foundation masonry, 3,920 cu. yds. wall masonry, 2,470 lin. ft. granite coping, etc.

RAILWAY TRACK SCALES.—Cleveland, O.—The Board of Control will receive bids until Oct. 19 for a standard gage railway track scale of 60 tons capacity, including the necessary foundations therefor and equipping the same ready for use.

WHARF.—Providence, R. I.—The Commissioner of Public Works has been authorized to purchase material and contract for the building of a wharf for the new city yard, to cost $54,000.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for six four-cylinder compound consolidation engines for the Toledo, Ann Arbor & North Michigan. The Cooke Locomotive & Machine Works, Paterson, N. J., have an order for five six-wheel switch engines for the Chicago & Western Indiana. The Pittsburg Locomotive Works, Pittsburg, Pa., have built a two-cylinder compound ten-wheel engine for the Pittsburg & Western, and have an order for 15 mogul engines, with cylinders 19×26 ins., for the Duluth, Messaba & Northern. The Union Pacific has built at its shops at Omaha, Neb., an eight-wheel passenger engine weighing 218,000 lbs. with tender loaded; it is to haul the mail trains over the continental divide between Cheyenne and Laramie, Wyo. The Long Island sold 30 engines at auction Oct. 7, including 14 eight-wheel passenger engines with tenders, 9 tank engines and 7 Fairlie engines with steam trucks. Some of these were too light for present service, and the Fairlie engines for suburban traffic have probably been replaced by the new four-cylinder Baldwin compound engines built for this traffic. Mr. S. F. Prince, Jr., is Superintendent of Motive Power. The Toledo, St. Louis & Kansas City will require 25 new locomotives during the next two years, according to a published statement of the president, Mr. R. Callaway, of Toledo, O.

CARS.—The Mount Vernon Car Mfg. Co., Mount Vernon, Ill., is building 1,000 Hicks patent stock cars for the Cleveland, Cincinnati, Chicago & St. Louis. The Lamokin Car Works, Lamokin, Pa., have the following orders on hand: two 16-ft. vestibule cars for Paterson, N. J.; six 18-ft. cars for Mahanoy City, Pa.; a 16-ft. closed motor car with McGuire truck for Gallipolis, O.; two 16-ft. motor cars on Robinson radial trucks for the Philadelphia Traction Co., and two 16-ft. cars for the Pennsylvania General Electric Co. The works noted last week as having been burned at Lima, O., were the car shops of the Lima Locomotive & Machine Co. The Bancroft Vestibule Car Co., Chicago, Ill.; $1,000,000; has been incorporated by George W. Bancroft, Martin E. Cole and Wm. P. Tuttle. The United States Rolling Stock Co.'s material and rolling stock at Anniston, Ala., were sold at receiver's auction last week, and were bid in by George W. Ristine, General Manager of the New United States Car Co. The new company has also leased the numerous plants of the old company, and formal transfer of the entire property has been made. The works were shut down about two years ago. It is thought that the rolling-mill department at Anniston and the works at Decatur will soon be opened. According to a published statement by Mr. R. Callaway, president, the Toledo, St. Louis & Kansas City will require during the next two years 10 passenger and baggage cars, 200 stock cars, 500 coal cars and 1,500 box cars.

RAILS.—The Carnegie Steel Co., Pittsburg, Pa., is making arrangements to roll light track rails weighing 30 to 45 lbs. per yd.

BRAKE SHOES.—The Safety Brake Shoe & Construction Co., 620 Atlantic Ave., Boston, Mass., is introducing a brake shoe in which wooden plugs are fitted into holes in the face. It is intended for street cars.

CEMENT WORKS.—The plant of the Fort Scott Cement Mfg. Co., at Fort Scott, Kan., was burned Sept. 28, the mill, storerooms, three box cars and 40,000 bbls. of cement being destroyed, but the kilns were saved.

CATTLE GUARD.—The following particulars of the test of a surface cattle guard are taken from a letter by Mr. L. A. Nichols, C. E., of La Salle, Ill., sent to the manager of the Standard Cattle Guard Co., Chicago:

I was one of the party to test one of your cattle-guards in May, 1892. The test was conducted in the usual manner, only that as a greater inducement the herd of cattle and hogs were divided, a few being left on one side and abundantly fed with corn close by the guard. Those on the other side, and they were of all ages, made many attempts to cross, but always pulled back after getting one foot on. This test was continued for about half an hour, and nothing had crossed. We then tried forcing, gently at first, but finally had to resort to considerable severity before we drove some of the hogs over, and failed entirely with the cattle, with the exception of one yearling which four of us with sticks finally induced to jump it. The best test, however, was unpremeditated. When the guard was put in place, an ordinary-sized dog was unintentionally separated from his master, and immediately became frantic to rejoin him. The master added to his anxiety by calling to him, and pretended to be going away. The dog tried all parts of the guard, running off several times around the yard endeavoring to find a way through the fence, and finally seeing all other means of escape shut off, did, with considerable fear and trouble, cross the guard.

COMPANIES.—New Jersey Power Co., Jersey City, N. J.; $150,000, all paid up; W. H. Wild, of Jersey City; H. D. Cooke, of New York; F. T. Cooke, of Washington, D. C.; H. L. Earle, of Leavenworth, Kan. Tomahawk River Improvement Co., Tomahawk, Wis.; $50,000; John Woodlock, Wm. H. Bradley and F. G. Stark. American Asphalt Co., Omaha, Neb.; for asphalt paving; $50,000; W. H. Warswick, Frank J. Kaspar and Edward Ainscow. East Peoria Paving Brick Co., Peoria, Ill.; $200,000; H. M. Fleming, Julius S. Starr and Delos S. Brown. St. Louis Car Axle Lubricater Co., St. Louis, Mo.; $100,000; W. H. Daniels, T. T. Miller and J. E. Thomson, New York. East River Ferry Co., New York, N. Y.; $750,000; R. Emmett Doherty, of New York; Geo. H. Conklin and Edwin Nellis, of Brooklyn, N. Y.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $16.50 to $17 for iron and $14 to $14.50 for steel. Pittsburg: old rails, $19.50 to $20 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; light rails, $32; old rails, $17.75 for iron and $12.50 to $14.25 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 60 and 10% and 50 and 10% on black and galvanized butt-welded; 70% and 60% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $14 to $15.50. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.75.

LEAD.—New York: 4 to 4.05 cts.; Chicago: 3.9 to 3.95 cts.; St. Louis: 3.8 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 1.95 to 2 cts. for large lots and 2.05 to 2.1 cts. for small lots; channels, 1.95 to 2 cts. for large lots and 2.05 to 2.1 cts. for small lots; angles, 1.85 to 1.95 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2.05 to 2.15 cts.; universal mill plates, 1.8 to 1.85 cts. for steel; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 cts. for shell, 2 to 2.25 cts. for flange, 3.5 to 3.75 cts. for firebox. Chicago: beams, 2.15 to 2.5 cts.; channels, 2.25 to 2.3 cts.; angles, 1.9 to 2.25 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2.05 to 2.15 cts.; steel plates, 2.1 to 2.4 cts. for tank and 2.45 to 2.75 cts. for flange.